SCIENCE

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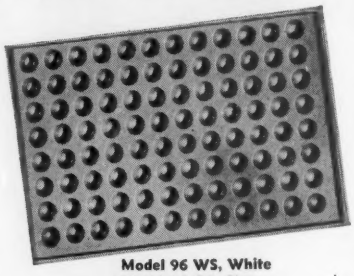

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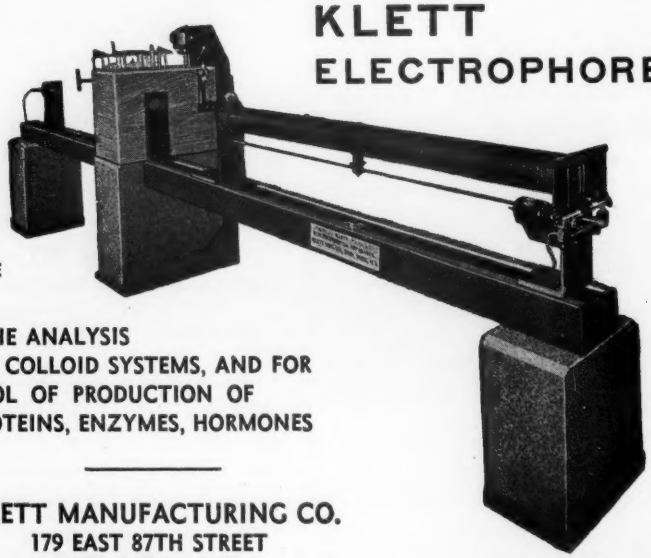

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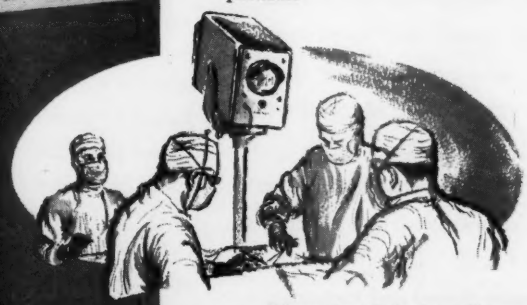

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Feedback

The competition for scientists and engineers has had some curious results. Recent hearings before the House of Representatives Subcommittee on Manpower Utilization and Departmental Personnel Management bring out the difficulties the Government has in recruiting and retaining scientists and engineers. Its own pay scale is one of the factors that puts the Government at a disadvantage. Starting salaries for college graduates of 1956 in engineering, physical sciences, and mathematics ranged from $410 to $427 per month in industry but were only $373 per month in Government. In the higher grades of federal employment (annual salary $8000 or more), the differential in pay for similar jobs in industry is $1000 or more.

There seems to be little doubt that the Government itself has played an important—though perhaps unavoidable—part in creating its own difficulties, for the Government contracts with industry for projects in defense, either on a cost-plus or a fixed-fee basis, thus bringing about an increased demand for scientists and engineers at the going-rate for industrial salaries.

In a similar way the Government competes against itself in recruitment. Industry can launch extensive recruitment drives by sending teams to college campuses every year and by vigorous advertising campaigns in a way that the Government cannot match—and all of this largely out of Government funds. Some figures prepared by the Department of the Navy on the costs of recruiting by firms with a preponderance of Government business compared with those with a preponderance of non-Government business show that the average cost per new employee for defense industry is $808 and the range is from $245 to $4702; for nondefense industry, the average cost is $502 and the range is from $0 to $2021. Representative Davis, chairman of the subcommittee, dramatized these differences by preparing tables based on the Navy data but calculated on the basis of the *net gain* of new employees. One defense firm, for example, spent $907,560 to gain 59 employees for a net cost per employee gained of $15,328. On the same basis the highest cost per employee gained in a nondefense firm was $2293.

Those firms that had a *net loss* of employees present what might be regarded as embarrassing gaps in the column entitled "Cost per new employee." One firm spent $100,674 and had a net loss of four employees, another spent $40,722 and had a net loss of 14 employees. One has to run pretty fast just to stay in the same place.

There is a strong movement afoot to put the Government in a position to meet industrial competition in salaries, if not in recruitment expenses. A Defense Department committee headed by Ralph J. Cordiner has recommended salary increases of from $500 to $3000 per year for employees of all higher grades (starting salaries from $4525 to $16,000) and Senators Johnson and Neuberger have introduced a bill recommending similar increases for the higher grades and raises of about 12 percent for the lower grades. Thus it looks as though the competition for scientists and engineers may have the effect of boosting Government salaries generally.

In general we approve but think it likely that industry would up the ante and thus continue the inflationary competition for talent. The problem is to find some way to apply the brakes without discriminating against the Governmental employee.—G. DUS.

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Teleology and Theory of Human Behavior

Robert B. MacLeod

In approaching the problem of fundamental concepts and units of social science, I do so merely as a psychologist. My colleagues in the other social sciences will have much to add, and they may well see fit to differ. I also limit myself to one topic—namely, the place of teleological constructs in the theory of human behavior. There is only incidental reference to the problem of units.

In reviving the old question of teleology, I realize that I am venturing down a pathway that for some centuries has appeared forbidding even to the angels, and that in taking a hesitant step in this direction I am identifying myself with a nonangelic group. Teleology means the explanation of natural events in terms of purposive constructs. This is a currently unpopular approach. I submit, however, that we should from time to time look again at the phenomena that invite a teleological explanation and make sure that we have done full justice to them.

Revolutions in Science

It is only recently that the students of man and society have been readmitted into the family of scientists. We appreciate the honor; we like to think of ourselves as scientists. Twenty-five hundred years ago, however, there was no question of a division within the family. Science, or philosophy, was one; it was man's quest for an understanding of everything. In Aristotle's day it included physics, biology, psychology, epistemology, logic, ethics, politics, and even the theory of poetry. In Aristotle's thinking there was no object or event or relationship that was not intelligible as an expression of law; and even the *summum bonum* was the embodiment of a rational principle. The Greek faith in reason was for many centuries to be smothered by a blanket of Christian theology. When the Greek faith was eventually revived, its claims were much more modest. The world of physical nature might be rationally understood, but the laws of human living were yielded to the theologians. The hope of modern social science is that the ideal of the ancient Greeks may some day be realized, that man may be restored to nature or, possibly, that our conception of nature may be broadened to encompass the laws of human behavior.

The history of science is studded with revolutions. The rationalism of the Greeks was revolutionary. In the 16th and 17th centuries we had a revolution of the New Science, as astronomy, physics, and biology began to throw off the shackles of the Christianized Aristotle. In Newton's great synthesis we have its finest expression. Darwin, in the 19th century, precipitated another revolution, the repercussions of which have not yet died down; and today we find ourselves in the midst of the greatest scientific revolution of all. History will in due course settle on a name for it. These are just the high points. In between the great revolutions there have been innumerable rumbles and revolts.

But where among the revolutions do we find the great revolution of the social sciences? We look for it in vain because it has not yet taken place. Why? I suggest that it is because the students of man have cravenly tried to pattern their fundamental concepts and methods after those of the natural sciences. I do not propose to canonize Aristotle, as the medieval theologians nearly did; but I do think that, just as the Renaissance was sparked by the rediscovery of the real Aristotle, so the social sciences of today can profit from a fresh look at Aristotle's argument for the unity of man and nature. The Renaissance scientists found his physics and his biology faulty, and we too may find weaknesses in his psychology and his sociology; but we cannot evade his challenge.

Aristotle's Causes

Aristotle's unified conception of the world rested on a fourfold theory of causality. There were material causes, efficient causes, formal causes, and final causes. Material and efficient causes had been recognized long before Aristotle. We find something like his formal causes in the materialism of Democritus. Final causes had, however, belonged to theology, and even the rationalist Plato had regarded them as separate from, if superior to, the laws of nature. The final causes represented the purposes of the gods, who, according to Greek mythology, could change the course of natural events at will. In the fourth century B.C. it required genius to incorporate final causes into a single teleological scheme that could include everything from the motions of matter to the creation of poetry.

The revolution of the New Science was in large part a revolt against Aristotle, but it was against an Aristotle who had been posthumously baptized as a Christian, whose final cause had become a Divine Purpose, the sole interpreter of which was the Church, and whose every dictum had become sacrosanct. Copernicus quailed before Authority, Galileo protested and then yielded, and Descartes quibbled; most of the scientists of the 16th and 17th centuries, daring as they were in their thoughts, hastened to make all possible concessions to Authority in

The author is professor of psychology at Cornell University, Ithaca, N.Y. This article is based on the third paper presented at a symposium, "Fundamental units and concepts of science," that was held 27–28 Dec. 1956 during the New York meeting of the AAAS.

order to retain some measure of freedom. One of the chief concessions they made was their freedom to consider man as a natural phenomenon. Even Newton, the model of the scientist, refused to study man in his entirety—and this at a time when the scientist could still be master of all knowledge.

The revolution of the New Science banished Aristotle's final cause, at least so far as physical nature was concerned, and even Aristotle's formal causes were laid open to question. The physical world that Newton envisaged was a world that could be described in terms of material and efficient causes, in terms of particles of matter that exist in space and time and are moved by force. Since Newton's day matter has lost much of its materiality; space and time have ceased to be absolutes, and force has been transmuted into a mathematical formula; but for all practical purposes the Newtonian scheme still works, and deep down we still have the conviction that Newton had his fingers on the fundamentals. Reality, our tradition tells us, Reality with a capital *R*, is tough and resilient stuff. No Science that is worthy of its capital *S* can ever really explain any phenomenon of nature without referring it to Something Real, like molecules or enzymes or genes or reverberating circuits in the cortex.

In the Newtonian scheme we seek in vain for anything that promises a true science of man. In the 16th century, the adventurous students of physical nature had rightly challenged the Christianized version of Aristotle's theory of the natural world. After the 16th century, the natural sciences went forward by leaps and bounds. By the end of the 19th century Science, with a capital *S*, promised to replace the gods of traditional theology. In retrospect, we realize that the scientists of the Renaissance had been faint-hearted when they were confronted with human problems, and that their successors were diffident about applying the principles of their new science to man. Galileo bowed before the Inquisition. Descartes, the father of mechanistic physiology, refused to extend his mechanical principles to the operations of the mind. Berkeley, who developed an ingenious (if incorrect) theory of space perception, took refuge in the mind of God. The philosophers eventually escaped with Kant into the realm of the transcendental. Early modern science was brilliant in physics, and only slightly less brilliant in biology, but in the science of man it was a dismal failure.

We cannot blame this failure on the social scientists of the Renaissance and post-Renaissance periods, for in those times there were no social scientists as such. The disciplines had not yet become specialized. At the end of the 16th century, Bacon could aspire to a mastery of all knowledge, and 200 years later Goethe could be active in optics, in botany, and in psychology as well as in the writing of poetic, dramatic, and philosophic works. If blame is to be assigned, it must be shared by all those who had the intelligence and the opportunity to look at themselves as scientific objects and who recoiled before the challenge. Better, however, to blame no one and simply to realize that societies and individuals must achieve considerable maturity before they can begin to study themselves scientifically.

Independence of Social Science

It was not until the latter half of the 19th century that the sciences of man began to assert their independence, and by that time the conception of science had become established as essentially that of Newtonian physics. We can understand how the students of man, groping for basic concepts and methods, should have patterned their explanations after Newton. The best example is to be found in the history of associationist psychology. The British empirical tradition was grounded in Newtonian physics. John Locke was living in a Newtonian world when he sought to base the primary qualities of sense on the properties of matter and to reduce the secondary qualities to terms of the primary. For Locke, the element of mental life was the "idea," the psychological analog of the Newtonian material particle. Locke was not completely consistent in his empiricism, for he conceded the existence of "mental powers."

During the succeeding century and a half, however, a completely associationist theory was gradually hammered into shape. By the mid-19th century, James Mill had banished the soul and the mind and had presented the world with a strictly Newtonian doctrine of man. The "mind" of man consisted of nothing but its contents, elementary sensations and ideas, chained together and compounded in accordance with a single law, the law of association by contiguity. Jeremy Bentham had similarly reduced the problems of individual and social motivation to a single principle, the principle of utility. Bentham's elements are simple pleasures and pains. Every human act is, and should be, based on a calculation of probable pleasant and painful outcomes. At the mid-19th century, it looked as though all the phenomena of human behavior and experience might be accounted for in terms of the prevailing concepts of natural science.

Newtonian science rests, essentially, on Aristotle's material and efficient causes. Newton was not an irreligious man, but he refused to admit teleology into the realm of science. Aristotle's formal causes may have caused Newton some trouble, but I have neither the space nor the scholarship to discuss the question. What is clear, however, is that psychological science in the mid-19th century was strongly opposed to the formal, as well as to the final, causes.

Then came Darwin. With Darwin there was a shocking upsurge of Aristotelian teleology. The historian of science must be amused by the fact that the most strenuous opposition to Darwin came not from the Newtonian materialists but from the pious people whose doctrine he was unwittingly to support. It is true that Darwinism was a threat to traditional religion, with its belief in special creation, and that Darwin's bulldog, Thomas Henry Huxley, smote the clerics hip and thigh, contending that man should be regarded not as a child of God but as a natural product of organic evolution.

What is most challenging about Darwin, however, is his reintroduction of purpose into the natural world. He may not have intended to do this—again, my scholarship is inadequate—but this was clearly one of the consequences. The Darwinian debate seethed with expressions, such as "nature red in tooth and claw," that seemed to suggest a mechanistic explanation of evolution, but these were accompanied by "the struggle for survival," "the progressive adaptation of species to their environments," and similar expressions that more than hinted at a final cause. The philosopher Bergson in his concept of the *élan vital* postulated something more than a mechanical principle; the biologist Charles Lloyd Morgan argued for the principle of emergence in evolution; the biologist Hans Driesch defended a frankly vitalistic position; the psychologist William McDougall made the concept of purpose central in his psychological system; the new science of anthropology took courage from Darwin's successes and proceeded to search avidly for evidence that would support an evolutionary theory of society. The defenders of religion, instead of yielding to the Darwinian enemy, finally encompassed him. Without much difficulty they recognized in the evolutionary principle a further indication of God's eternal purpose. Darwin, the scientist who tried to restore man to the realm of natural law, became the unintentional herald of a new teleology.

Final Causes

As I have said, I am not trying to canonize Aristotle, but I believe that Aristotle's doctrine of causation may still have some relevance. For almost 2000

years after his death the final cause reigned supreme. This was the period during which science, such as it was, was dominated by the Church. The revolution of the New Science, symbolized by Newton, represented an attempt to explain all of nature in terms of material and efficient causes, but it ran into difficulty when it tried to encompass the facts of human nature.

The Darwinian revolutionaries, perhaps unwittingly, reintroduced the final cause, and the stage was set for a debate between those who would explain nature mechanically and those who would explain it teleologically. Aristotle would not have been bothered by this difference of opinion, for he believed in the ultimate rationality of everything; but the post-Darwinian Newtonians, especially in psychology, have been bursting blood vessels in their attempt to contain the explanation of human behavior within the dimensions of space, time, mass, force and motion. Psychologists, of all people, ought to be keenly aware of the implicit assumptions in their own thinking. What is appalling is the evident fact that American psychologists are still trying to fit their phenomena into a Newtonian framework even after their hero, the physicist, has long since been toying with non-Newtonian concepts.

What I suggest is that the social scientists take another look at Aristotle's *formal* causes. The natural scientists did pretty well with the material and efficient causes; the final causes were captured by the theologians. The formal causes were lost in the shuffle. The Newtonians tried to dispose of them; the theologians tried to absorb them. It seems to me that the concept deserves further scrutiny. Let us glance at just a few examples.

The principle of homeostasis, originally propounded by Claude Bernard, was buttressed by experiment and presented as a theory by Walter B. Cannon. Cannon, in a presidential address before the AAAS, even dared to extend its application to the body politic. Physiological homeostasis is the principle whereby the body reacts to changes in its environment in such a way as to maintain steady states—steady states of temperature, water content, salt content, calcium and phosphorus content, and so forth. A physiological need generates a psychological need, and the appropriate behavior restores the proper balance.

It is important to note, however, that Cannon's steady states are not mere statistical averages; they are optima. The temperature at which the human body functions best, as recorded by a mouth thermometer, is 98.6°F. This is not an average of all possible temperatures; it is a statement of the *optimum*. Cannon's principle suggests that when organisms are disrupted they will veer toward a norm. Can this be explained in terms of material and efficient causes? Or does it require something more?

For the past 100 years, experimental psychologists have been familiar with the problem of phenomenal constancy. Under conditions of free vision, the object we see retains its apparent size in spite of changes in distance from the eye and consequent variations in the size of the retinal image; and its color, shape, and position are similarly resistant to changes in its illumination, orientation, and location. Some of the laws of phenomenal constancy have been worked out empirically and stated quantitatively. Yet, in advance of experimentation, we can still predict with a high degree of assurance on the basis of such a proposition as "The organism will strive, so far as possible, to preserve a stable world of objects, events and relationships." Is this a teleological principle?

A scant half-century ago, Sigmund Freud, who had begun to explore the causes of neurosis, concluded that the individual in his development achieves an ego that defends its integrity against real or imagined onslaughts from the world about him. Repression, rationalization, sublimation, projection, and reaction-formation are familiar mechanisms of ego defense. None of these has been adequately quantified, yet the psychological clinician depends on them. He knows that he can understand his patient's symptoms and guess his patient's future behavior if he assumes that the patient's ego will strive, by hook or by crook, to defend itself against attack. Some day the machinery of ego defense will be dissected into its nuts, bolts, switches, and transmission lines. For the present, what looks like a teleological principle seems to work.

These examples are from physiology, experimental psychology, and clinical psychology, and they could be extended indefinitely. I feel less confident about examples from economics, sociology, and anthropology, although I am told that there is still a law of supply and demand in economics and that the introduction of a new artifact into a society, such as a steel axe or a hydrogen bomb, will have predictable social consequences.

What is interesting is that in the sciences of man—and I include physiology—we can often make our best predictions on the basis of macroscopic observations and generalizations. The microscopists may eventually verify, or even correct, our statements, and they are beginning to do this in the fields of homeostasis and phenomenal constancy; but the fact remains that the initial hypothesis, the initial hunch, springs from an intuition as to whither man is going. Are we to exclude the directedness of human behavior from the realm of science as the Newtonian physicists did? Should we try to reduce directedness to terms of material and efficient causes, as the 19th-century psychologists did? Or shall we accept as facts the phenomena that invite a teleological explanation, and see what we can do with them? Needless to say, I favor the last alternative.

Teleological Explanations

I am not arguing that science should suddenly have a change of heart and reinstate Aristotle's final causes. The physical sciences have done fairly well without them. The biological sciences seem to be admitting formal causes without yielding to final causes, although some biologists are striving manfully to reduce formal to material and efficient causes. What I do suggest is that the social sciences, dealing as they do with the very phenomena that invite a teleological explanation, should not scurry away from these phenomena but should look at them fearlessly and be prepared to think in more global terms. A quarter of a century ago a much maligned psychologist, William McDougall, analyzed what he called "the marks of behavior," the most important of which was purposive striving. I think he was right. Among the many things that are characteristic of organisms is that they strive toward goals. We may deduce goals from the observed behavior of simpler organisms or we may observe them directly in our own experience. The fact remains that goal directedness is something we can observe. If science is to include the behavior of man, it must include the fact of purposive striving. Sticks and stones do not strive, but people do.

The most influential of contemporary psychologists, the American behaviorists, are still trying to stuff the science of man into a Newtonian bottle. They would like to see all of human behavior plotted bidimensionally within a simple scheme of space-time coordinates. I do not really deplore this. The scheme works well with rats, and with human beings who have the fortitude to memorize endless chains of nonsense syllables. It is a healthy and humbling experience to know that human, as well as animal, organisms can be made to behave like well-oiled machines.

In a world that cries for a deeper understanding of man, however, a world in which physical science has granted enormous new powers to a human agent who has scarcely begun to understand himself, I think it is high time that the students of man stop pretending to be scientists in the traditional sense and settle down to the business of looking at

man as he really behaves. I have no thought of disparaging Newton or his conception of the scientific conscience. I am simply suggesting that some of the phenomena that Newton rejected may now be incorporated within a broadened conception of science. These are the phenomena of form and purpose. Let us look at them as facts.

Some of my physicist friends object to my capping the history of scientific revolutions with a reference to an Einsteinian revolution, and they may be right. Einstein may not have revolutionized our conception of the physical world; but for us, social scientists, he is sufficient as a symbol. Einstein means to us not only the revolt against the rigidity of the Newtonian system but also the correction of a superficial relativism that has lulled too many social scientists into easy generalities. We usually think of Einstein's challenge as a challenge to our theory of space. For the social scientist it is *time* that is more important, for time is an essential dimension of purpose. If time runs in a straight line, then the only things we can consider as the causes of an event are the antecedent and concomitant conditions. The Newtonian system restricts us to these. If, however, we question the absoluteness of time and play with the idea that, in different frames of reference, the relationship between antecedent and consequent may be reversed, we may be left free to think that something that has not yet happened may be an essential condition of something that is about to happen. If the temporal relationship is relationally, rather than absolutely, determined, we might conceivably reincorporate purpose as a natural fact into the stream of natural causation.

Conclusion

My present feeling is that, if we were to reintroduce final causes now, we would be moving too fast. Some day we may have a natural science that is broad enough, both in its concepts and in its methods, to include the facts of human purpose. For the time being, I think it is expedient to concentrate on Aristotle's formal causes, and I suspect that the solution of formal causality may automatically resolve the problem of final causality.

One's thinking is always culture-bound. My own bias is against any sort of teleology. I do not want to admit transcendent, or even immanent, purposes into the universe. This may be a relic of my Newtonian upbringing. Nevertheless, the facts of human behavior and experience reveal purposiveness. Shall we consider these as facts of nature, or shall we deny them? If we accept them, shall we reduce them to "purposeless" terms, or shall we try to discover a unified science that is broad enough to encompass the full richness of experience?

Scientific Outlook: Its Sickness and Cure

Michael Polanyi

In the days when an idea could be silenced by showing that it was contrary to religion, theology was the greatest single source of fallacies. Today, when any human thought can be discredited by branding it as unscientific, the power exercised previously by theology has passed over to science; hence, science has become in its turn the greatest single source of error.

In saying this I am not rebelling against the preponderant influence of science on modern thought. No, I support it. But I am convinced that the abuses of the scientific method must be checked, both in the interest of other human ideals which they threaten and in the interest of science itself, which is menaced by self-destruction, unless it can be attuned to the whole range of human thought.

Lest these opening words sound vague and exaggerated, I shall nail down their demonstration forthwith by one name of two syllables: by the name of Lenin. The voluminous writings of Marx may point in various directions; the unspeakable deeds of Stalin are bordering on the pathological; but Lenin's doctrine is fairly clear and consistent. Let me show that the intellectual power by which it so widely triumphed both over its rivals and opponents was its claim to scientific certainty.

R. B. MacLeod has drawn a line directly from Newton to Bentham, and thence to modern sociology (*1*). This line is indeed the very axis of modern social theory. But the Newtonian outlook, as prefigured by Galileo and Gassendi, had established—by the work of Hobbes—a mighty bridgehead in political thought, even before the advent of Newton. In his *Leviathan* Hobbes founded for the first time a theory of society on the utter selfishness of its members, and his genius already foreshadowed there the monstrous tyranny that this conception of society may justify. On the other hand, MacLeod's axis should also be extended forward beyond Bentham, directly to Marx and Lenin. Dialectical materialism is a radically utilitarian conception of a progressive society that is advancing through conflict. It sees history moving inevitably toward greater productivity and regards this movement as the result of the rise of new classes over the dead bodies of obsolete social systems. It claims also that each new revolution of this kind is accompanied by comprehensive changes in law and morality, in philosophy and the arts, and, indeed, in every branch of human thought. This inexorable historic process bears the features of a new leviathan. It is the leviathan of Hobbes equipped with jet propulsion. Its driving force is supplied by a fierce demand for social justice—but these moral motives remain curiously concealed inside the monster.

Morality in Disguise

Herein lies a characteristic feature of all Marxist theory and Marxist policy: moral passions are masked as scientific laws which, by defining a historic necessity, sanction the machinery of violence which fulfills the necessity. Engels said that Marxism had transformed socialism from a utopia into a science. But actually, Marxism still relies on the emotional force of its utopian aspirations and

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merely disguises them as scientific predictions.

It is important to understand this peculiar structure. The scientific disguise provided by Marxism not only protects its moral aspirations from being discredited as mere utopianism but actually enables these aspirations to dominate from inside the pronouncements of Marxist theory and thus to direct its political machinery. Marxism establishes thereby a coupling between moral motives and political action, which is the exact opposite of that usually described as *rationalization*. There is no question here of concealing greed behind moral pretenses. Quite the contrary: genuine moral motives are given a chance to operate by concealing them within a scientifically respectable machinery of acquisitive violence.

I regard this as the ultimate stage of utilitarianism. Bentham justified morality by its usefulness. Marx agreed but changed the emphasis by saying: Morality is *nothing but* a disguise for greed. *All* sheep, he said, are but wolves in sheep's clothing. Bourgeois morality is the sheepskin for capitalist wolves to hide in; wolfishness is the real objective force in history. Marx despised socialists like Fourier and Owen, who appealed to the noble sentiments of the ruling classes, for in his view they were but sheep appealing to wolves. I would agree that Marx effectively superseded the utopians by his allegedly scientific socialism, but I would add that this scientific socialism was merely a disguised utopianism rendered scientifically acceptable by being cast for the part of a wolf—the wolf of merciless class war. The moral passion of utopianism lived on within the wolf, its hunger for righteousness being transformed into the rapacity of the wolf. Such is the Marxian leviathan.

This is how the curious structure was formed—fatefully characteristic of our age—of high moral motives disguised as scientific predictions, and secretly injected into the engines of merciless power. This is moral man's flight into captivity, a process which I have described elsewhere as a "moral inversion" (*2*).

However, it might be objected that Marx, or his executors, did not really proceed scientifically, the very fact that they became such fanatics being proof that they did not preserve their scientific detachment.

But then, what about Bentham? Bentham, whom MacLeod rightly acknowledges as the very fountainhead of a "Newtonian" social theory? From his utilitarianism flowed the most powerful intellectual force for the reforms which changed the face of England during the first four decades of the 19th century. This shows that Bentham, like Marx, used his scientific analysis of society as a disguise for his moral aspirations.

The progression from Bentham to Marx was due mainly to the intensification of the moral demands made on society in the course of the French Revolution and of the subsequent rise of Utopian Socialism. The moral dynamism of the 19th century had to be cast into a more violent conception of historical progress than that which could satisfy the reformers of the 18th century. There is a parallel progression in the development of nihilism. Bentham's contemporary, the Marquis de Sade, reacted to the mechanistic conception of man by a sweeping contempt for all morality, expressed by devoting his life to the practice and his writings to the apologia of sexual debaucheries. By contrast, the Russian nihilists of the mid-19th century, guided by the same supposedly scientific view of man—and deriving from it the same contempt for all accepted morality—turned this contempt into a hatred of all existing society and thence into a total dedication of themselves to the task of a merciless social revolution. This is why the doctrine of totalitarian terror, which was not prevalent in the Western interpretation of Marxism, was unhesitatingly proclaimed by Lenin as the true teaching of Marx. He responded to the example of Russian nihilism.

Results of Detached Analyses

Thus it would seem that for better or for worse—for better in Bentham, for worse in Lenin—the supposedly detached analysis of morality always comes out heavily charged with moral, immoral, or "morally inverted" impulses. And I think this has a simple explanation which confirms MacLeod's apprehensions concerning the "Newtonian" study of human beings.

For surely, there are a great number of things our knowledge of which dissolves if we look at them in a thoroughly detached manner. The meaning of a word vanishes if I cease to mean anything by it; the proof of a mathematical theorem dissolves if I cease to trust it; and, likewise, a moral ideal dissolves if I stop respecting it. I cannot know that someone, say Lincoln or Gandhi, was a great man unless I revere him. You need reverence to observe human greatness, just as you require a telescope to observe spiral nebulae. But reverence is not an objective approach in the tradition of Newton, and hence our ideals—along with the greatness of men who embody these ideals—must cease to be visible if they are approached objectively in this Newtonian sense.

From this moment a process of moral inversion sets in. For once the frank expressions of our moral passions are discredited by a detached scientific approach, they will seek some outlet which is protected against our scientific self-doubt. The various forms of scientifically denatured morality which have emerged during the past two centuries are but different outlets for frustrated moral passions. These passions may break out in an abject sensualism à la Sade, culminating in frenzied destruction, for only such Satanism may appear completely honest and entirely safe from any suspicion of bad faith. Many threads of this Satanism are found woven into modern Continental thought, and they are prominent in modern French existentialism.

The English-speaking peoples favored less radical methods for rehousing the moral passions rendered homeless by the scientific outlook. Following Bentham's guidance, they endowed some relatively neutral vocabulary, like that of utility, or social adjustment, or mental health, and so on, with the meaning of the moral terms for which they were to serve as scientifically respectable substitutes. This pretense safeguarded good sense and benevolence under inadequate scientific designations, and thus allowed moral passions to operate effectively by stealth.

Yet though the draping of moral life in the terms of a nonmoral language can protect moral ideals against destruction by scientific analysis, such a situation might finally prove unstable. Men may not pursue their moral ideals indefinitely within a conceptual framework which denies reality to them. Not because they will become indifferent to morality—which is rare—but because they may slip into the logically more stable state of complete moral inversion. A great upsurge of moral passions is likely to cause a break-through in this direction. This is what happened, as we have seen, under the impact of modern dynamism in the totalitarian revolutions of our time over immense areas of Europe and Asia.

Social Sciences

However, am I not neglecting the social sciences in the academic sense, which MacLeod had primarily in mind in voicing his apprehensions? Not quite—for my survey of the contemporary scene has prepared my criticism of academic sociology and social anthropology. It has reminded us that all the live issues of our tumultuous age originated from the upsurge of a new moral dynamism. And it has exposed thereby the incongruity of adopting at this moment, as modern social anthropology has done, a strictly detached observation of society.

I am referring to the prevailing functionalist method in social anthropology.

This approach regards any institution, custom, or idea as fulfilling its function to the extent to which it contributes to the stability and coherence of the existing society. No matter how cruel, treacherous, or abysmally stupid a custom may be, it will be presumed to fulfill a social function in this sense. For example, the butchery of innocent people on the charge of witchcraft is said to solve the problem of satisfying hate, while keeping the core of society intact (*3*). The head-hunting of the Eddystone islanders is said to have kept their economic system functioning (*4*). Such views, though highly speculative, may be true and even interesting within the framework that they set to themselves. But at the same time, this approach produces a set of terms in which the most important distinctions are eliminated. It replaces morality by conformity; if an action falls short of conformity it is a "maladjustment" or a "deviance." Pickpockets and prophets, Hitler and Gandhi, Jesus of Nazareth and Judas Iscariot, are all classed together as deviants; a functionalist anthropology cannot distinguish between them.

At least it could not do so if it were strictly consistent. For admittedly, some moral sentiments are allowed to break through in the disguise of certain supposedly descriptive terms: terms like *aggressiveness* or *competitiveness* or *authoritarian personality*. Sociologists join forces here with psychiatrists in disguising their condemnation of social wrongs as the diagnosis of a mental disease. Thus, 20 years ago when Hitler's rise fatally challenged our courage and intelligence, a whole literature of analytic treatises poured forth, propounding that wars were the result of pathological aggressiveness, caused mainly by training infants too soon to cleanliness (*5*). This literature may sound foolish today, but it is not mentioned here in order to make fun of its authors. It should demonstrate, on the contrary, that even the most distinguished minds can produce nothing truly relevant to human affairs if they restrict themselves by the kind of detachment which is currently supposed to be the mark of scientific integrity.

In his recent Josiah Mason lectures, Sprott pleads that since man has been studied for so long in the past it is "no wonder [that] modern sociology brings so few surprises" (*6*). But surely the last 40 years have brought many surprises in the doings of men in society. Nor have revealing studies of these been lacking: Sidney and Beatrice Webb, F. A. Voigt, von Hayek, Rauschning, Heiden, Alan Bullock, Orwell, Koestler, Hannah Arendt, Czeslaw Milosz, Mitrany, Schumpeter, Carr, Churchill—no one can go through this list of names without recollecting some books which have profoundly affected his outlook on contemporary society. Other authors of similar gravity come easily to mind, but there are admittedly few sociologists who qualify to this class.

Participation

I would suggest that we might begin to remedy this weakness by prohibiting the use of the term *scientific* in praise of a study of human society, for a trial period of, say, 10 years. And in the meantime we should try training ourselves to study human affairs by intense participation in human problems instead of by detachment from them. We should know by now that the most powerful moral influence flows from the terms in which morality is interpreted and that the interpretation of history is a decisive force of history. A self-consistent society must therefore include within its orthodoxy the terms in which it states its orthodoxy. A consistently moral society must foster a moralizing sociology and historiography, and it must sustain a philosophy justifying morality and moralizing, as well as its own role as the justifier of these. I think we must depart all this way from the ideal of detachment in order to meet the challenge voiced by MacLeod concerning the Newtonian approach to human affairs.

Biology

And now I should like to level a similar anti-Newtonian challenge on R. W. Gerard's paper (*7*). I do admire his paper, but I am afraid that this compliment is somewhat left-handed. For I am inclined to consider the fact that a so learned, ingenious, and imaginative survey of living beings should deal so perfunctorily with some of the most important questions concerning them, as indicating a fundamental deficiency in biological thinking.

Gerard says that every higher type of organization is "understandable in terms of the units and their relations of which it is built" and adds that if we fail to predict their properties from those of their units, this is due to lack of information about the circumstances, subject to unspecifiable chances. What does this mean? Of course, if the "relations" of the units from which an organism is built include their relations *within* the organism, then the statement says no more than that the organism is composed of parts. If, on the other hand—as it would seem—the relations which explain the organism are thought to be those which the parts are known to manifest *outside* the organism, then the statement is certainly untrue. Electrons and nucleons are not known to be sentient, while the higher animals are. If a rat laps up a solution of saccharine, the rational explanation of this lies in the fact that the solution tastes sweet and that the rat likes that. The tasting and liking are facts that physics and chemistry as known today cannot explain.

And this conclusion gives the whole show away. Because it acknowledges a conscious desire by an individual capable of such desire, it leads on further to the recognition of deliberate actions by individuals and the possibilities of error on their part. Thus a whole series of conceptions emerges that are absent from physics and chemistry as known today. Indeed, nothing is relevant to biology, even at the lowest level of life, unless it bears on the achievements of living beings: achievements such as their perfection of form, their morphogenesis, or the proper functioning of their organs; and the very conception of such achievements implies a distinction between success or failure—a distinction unknown to physics and chemistry.

But the distinction between success and failure is present in, and is indeed essential to, the science of engineering; and the logic of engineering does substantiate in fact what I am saying here of biology. No physical or chemical investigation of an object can tell us whether it is a machine and, if so, how it works. Only if we have *previously* discovered that it *is* a machine, and found out also approximately how it works, can the physical and chemical examination of the machine tell us anything useful about it, as a machine. Similarly, physical and chemical investigations can form part of biology only by bearing on *previously established* biological achievements, such as shapeliness, morphogenesis, or physiological functions.

A complete physical and chemical topography of a frog would tell us nothing about it as a frog, unless we knew it previously *as a frog*. And if the rules of scientific detachment required that we limit ourselves exclusively to physical and chemical observations, we would remain forever unaware of frogs or of any other living beings, just as we would remain ignorant also by such observations of all machines and other human contrivances.

The achievements which form the subject matter of biology can be identified only by a kind of appraisal which requires a higher degree of participation by the observer in his subject matter than can be mediated by the tests of physics and chemistry. The current ideal of "scientificality" which would refuse such participation would indeed destroy biology but for the wise neglect of consistency on the part of its supporters.

But again, as in social theory, it is perilous to rely indefinitely on a conceptual framework that denies reality to the things we actually believe in. Shall we

continue, for example, to think of ourselves as automata? Speaking at a symposium of unrivaled distinction on the subject of "Cerebral mechanisms in behavior" in 1948, K. S. Lashley declared: "Our common meeting ground is the faith to which we all subscribe, I believe, that the phenomena of behavior and of mind are ultimately describable in the concepts of the physical and mathematical sciences" (*8*). Gerard, who was one of the participants on whose behalf this was said, has—it seems to me—reaffirmed this faith in his paper.

It is in fact taken almost universally for granted among neurologists, who regard its acceptance as inherent in their claim to be scientists. Yet I do not think that anybody can hold this belief. It assumes, for example, that Shakespeare's conscious thoughts had no effect on the writing of his plays; that the plays have been performed ever since by actors whose thoughts had no effect on what they were doing, while successive generations of audiences applauded them without being affected by the fact that they enjoyed the plays. Awareness, of which Gerard speaks only in skeptical quotation marks, was granted to Shakespeare apparently only to keep him quiet while his nervous system got through the job of getting his plays written.

Ideal of Scientific Detachment

Once more, I do not say these things here in order to ridicule the great scientists who insist on the necessity of holding such curious beliefs, but to make you aware of the terrific compulsion under which they stand: the misleading compulsion exercised today by the ideal of scientific detachment.

If this ideal could be removed by a revised conception of scientific merit, the relation between mind and body could perhaps be reconsidered on the following lines. Admitting that no process known to be governed by the present laws of physics and chemistry is also known to be accompanied by consciousness, we might yet suppose that a future enlargement of physics and chemistry might account for the sentience of certain material structures. It would seem unwarranted to retain for such structures the conception of automatic functioning, which is derived from our *present* physics and chemistry. Action and reaction usually arise together in nature. Hence, it would seem reasonable to expect that the new physics and chemistry, which would account for the production of consciousness by material processes, would also allow for the *reverse* action, that is, of conscious processes acting on their material substrate.

Only such a conception of the human mind can acknowledge our claim to responsible personhood and account for the obligation to treat our fellow-men as responsible persons. It alone makes it possible to acknowledge the inherent independence of a mental growth which—though conditioned by circumstances—is never determined by circumstances. It confirms, therefore, men's capacity, and their right, to serve the growth of thought; to seek the truth, aiming at universal validity according to their own lights. It permits us to hope that the firmament of ideals, from which we seek guidance for our judgments and actions, may reflect to some extent the proper meaning of our existence; and that other men, everywhere, are guided in fact in their own way by the same endeavors. Thus it makes it possible to conceive of a free society in which these independent strivings will compete without mortal conflict. It makes it possible to understand that the Soviet empire, founded on the assumption that thought should be fashioned by the government in order to provide itself with intellectual support, is now shaken by the rebellion of a people suffocated by the imposition of a system of slipshod, dreary falsehoods.

Behavioral Science

But I will be accused of wandering far beyond the responsibilities of science. The question for science, I shall be told, is simply, what can and what cannot be observed. I shall be told that all that can be observed in a fellow-human being is behavior, and that there is no occasion therefore to refer to mental states which not being observable are no concern of science. This is the behaviorist argument, and I think that both MacLeod and Gerard dislike it, though they do not actually refute it. Let me show how I would try to meet this argument and would establish the observability of another man's mind by an epistemology based on an extension of Gestalt theory.

I think the behaviorist argument goes wrong by failing to take into account the difference between observing the workings of a mind as mere events, as distinct from reading them as the signs of a mind's working. It is the same difference as that which obtains between focusing on the individual letters in a written text and reading the text. The first is a detached observation, the second I would call a convivial appreciation. I would go on from here to assert that the objective, "focal," observation of an intelligent mind's workings is impossible. You simply cannot keep track of the mind's workings in this manner. It is not possible to specify the particulars of an intelligent behavior, and in fact you cannot even recognize the course of such behavior, except by following its particulars comprehensively as the manifestations of an intelligence at work through them. But the moment you take in the totality of the unspecifiable particulars which compose intelligent behavior, you are not focusing on these particulars, you are not observing them in a detached manner, but are focusing on the mind beyond them, on the mind that is at work in these particulars. You are actually observing the mind "convivially" in terms of particulars of which you remain only subsidiarily—and often only quite vaguely—aware (*9*).

Behaviorists claim falsely that they observe the particulars of learning or intelligence without relying on their previously established mental context. This is sheer pretense. The terms used by them would be unintelligible but for the fact that we appreciate the achievements of their subjects by the exercise of our imaginative fellow feeling. It is this direct observation of the mind that is primary, and the objectivist terms in which it is cast are merely a subsequent elaboration of it which, though not without interest, must not be allowed to serve as a disguise and a substitute for the direct cognizance of the mind from which it is derived and by which it remains guided.

Admittedly, the observation of another mind involves a participation in our subject matter which clearly exceeds the limits which the ideal of greatest possible detachment would set us. But this in my view only demonstrates once more the falsity of this ideal. The observation of the ascending levels of organization surveyed by Gerard requires a steadily increasing degree of participation of the observer in his subject matter. And only by acknowledging this fact can the observer recognize the consecutive levels of integration as consecutive levels of new being, not specifiable in terms of lower level particulars.

Then it will be possible also to acknowledge that the human mind, though conditioned by the nervous system, is pursuing in essential independence its own nonmaterial objectives. And science can thus be attuned to the other domains of human thought and cease to threaten them by its false standards of detached objectivity. Science can be reconciled then once more with the truth.

Physical Sciences

I shall not try to show, though I believe it to be the case, that the false ideal of Newtonian objectivity has caused as much harm to psychology as it has to sociology. I propose to close on a happier note by congratulating the exact sciences, so attractively represented by Jerrold Zacharias (*9*), on being free from this kind of trouble. They seem to be doing splendidly, in spite of being—in my view—generally mistaken in what they *think* they are doing. The lighthearted manner in which Zacharias dis-

cussed the possible alternatives which his measurements of time may reveal is not merely an expression of his modesty: it flows from the current view that scientific theories are but convenient summaries of observed facts, or mere working hypotheses, or interpretative policies.

This noncommittal view of scientific theory can be traced back to antiquity, and it came into prominence first in the conflict between theology and Copernicanism. Pope Urban VIII insisted that Galileo should regard the Copernican theory as a mere practical device for computing planetary motions and not as a real explanation of the facts. Indeed, right from the publication of the Copernican theory in 1543, the Copernicans fought bitterly against his positivistic view of the theory, on which Catholic and Protestant theologians equally insisted. It was Newton who finally dealt the death blow to this view by his theory of gravitation, published in 1687.

This conception of science, which had been used so far only to reduce the status of science and to uphold the supremacy of religious dogma, was revived two centuries later by Mach for the purpose of strictly limiting the claims of science to observable facts. It has since become universally accepted. Yet this theory of science is but another pretense, practiced in deference to a false ideal of science. Take the theory of general relativity for which the project of Zacharias promises to supply a decisive test. Since its first publication 40 years ago, general relativity has held a position of supreme interest in science. But it would be grotesque to describe it as the most convenient summary of the facts predicted by it. There are hardly any such facts, and such as there may be can be memorized in a few minutes, while the understanding of these facts by means of the general theory is a task requiring years of preparation even by specially gifted students. Actually, the program of the general theory was first set out by Mach in 1883, without any experimental evidence to support it. It has held the allegiance of science and of the whole world by the intellectual beauty of its representation of the universe. Its rationality was regarded as a token of its truth, exactly as the rationality of the Copernican theory was so regarded by its early adherents who fought and suffered to uphold this truth.

Let us drop these pretenses. No scientist is ever concerned with producing the most convenient summary of a given set of facts. This is the task of the editors of encyclopedias and the compilers of telephone directories. It is of the essence of a scientific theory that it commits us to an indeterminate range of yet undreamed consequences that may flow from it. We commit ourselves to these, because we believe that by our theory we are making contact with a reality of which our theory has revealed one aspect. It is this commitment that lends universal intent to a scientist's most original solitary thoughts. By acknowledging this frankly, we shall restore science to the great family of human aspirations, by which men hope to fulfill the purpose of their existence as thinking beings.

So it would seem that by abandoning the false ideal of detachment in the epistemology of the exact sciences, we are led back to the point once more which we had reached by a critique based on a similar revision of our scientific ideals in respect to sociology and biology.

References and Notes

1. R. B. MacLeod, *Science*, this issue.
2. M. Polanyi, *The Logic of Liberty* (Chicago, 1951), p. 106; expanded in *Encounter* 7, No. 6, 5 (1956).
3. C. Kluckhohn and D. Leighton, *The Navaho* (Harvard Univ. Press, Cambridge, Mass., 1946), p. 176.
4. V. G. Childe, *What Happened in History* (Pelican, London), p. 15.
5. E. Glover [*War, Sadism and Pacifism* (London, 1935), p. 38] explains war as follows: "Tearing up 'scraps of paper,' 'violating' an 'innocent little country,' defending the 'mother' country, however much they refer to current realities, are but echos of many phantasies in which the 'good' mother or child is defended against the sinister (mostly sexual) designs of the phantasied 'bad' father." In the chapter entitled "The problem of prevention," we find on page 108 the following suggestion: ". . . to find out . . . how many dictators, foreign secretaries, diplomats and peace delegates suffer from psycho-sexual impotence or have a secret fear of impotence. A prerequisite is the common recognition of the important facts that impotence in some cases contributes to pacific tendencies, whilst unconscious fear of impotence is a common cause of war-mindedness and grandiosity." For a textbook summing up 11 years later the results of this movement, with a special emphasis on the role of early toilet training, see Kimball Young, *Social Psychology* (New York, 1946), for example p. 44.
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10. J. Zacharias, *Science* 125, 427 (1957).

F. W. Hodge, Anthropologist and Editor

On 28 September 1956, there died in Santa Fe, New Mexico, a man whose work will never be forgotten—Frederick Webb Hodge. He combined a deep knowledge of the archeology, ethnology, and history of the Southwest with a rare gift for writing and editing. He had a wonderful memory, a lively sense of humor, and talent as a raconteur.

"Téluli," as he was affectionately called by the Zuñi Indians and many of his other friends, was born at Plymouth, England, in 1864, and was brought by his parents to the United States at the age of 7. He was raised and educated in Washington, D.C., attending Columbian (now George Washington) University.

His first interest in the Southwest was aroused while he was field secretary for the pioneer Hemenway Archeological Expedition, from 1886 to 1889. This gave him the opportunity to see historic towns, meet living Indians, and study the ruins left by their ancestors. From that time on he never forgot the Southwest.

After his return to Washington he was employed by the Smithsonian Institution, at first in the office, then in the Bureau of American Ethnology, where he rose to the post of ethnologist-in-charge in 1910—a position he held for 8 years.

It was during his earlier years at the bureau that he accomplished the work for which he will be best remembered—the creation of the *Handbook of American Indians*, in two thick volumes, containing together more than 2000 pages. This handbook includes all kinds of information, alphabetically arranged, on the first Americans, with many illustrations. Hodge collected this material from various sources, writing some of the items himself and handling the editorial work, which must have been a heavy task. The *Handbook* still remains the best reference work on the American Indian, although the second volume was published in 1910, 46 years ago.

In addition to his work for the bureau he edited the *American Anthropologist*, as well as most of the American Anthropological Association's *Memoirs*, from 1898 to 1917.

Hodge left the Bureau of Ethnology in

1918 to join the staff of the Museum of the American Indian, Heye Foundation, in New York, where he edited all the museum publications and conducted a number of archeological "digs," especially at the ruins of Hawikuh, near Zuñi, New Mexico, one of the "Seven Cities of Cibola."

In 1932 Hodge became director of the Southwest Museum at Los Angeles, a position he held with distinction for 22 years. Here again he edited all the museum publications. And somewhere along the line he found time to edit the magnificent Curtis series of 20 volumes on the North American Indian.

Hodge was also a prolific writer, his bibliography containing more than 350 items dating from 1890 to a few days before his death—monographs and articles for historical and scientific publications. Many writers sought his advice or induced him to compose a foreword for a forthcoming opus. Absolute accuracy was his watchword, and he was asked to weed out errors from many a manuscript, which his wide knowledge and remarkable memory enabled him to do.

He was one of the founders of the American Anthropological Association and of the Quivira Society and was a member of many other scientific organizations.

In 1955 Hodge was granted a year's leave from the Southwest Museum. Early in 1956 he retired and moved to Santa Fe, the heart of the land he loved. Here, he was working on a study of the Apache Indians at the time of his death.

MARK R. HARRINGTON
Southwest Museum,
Los Angeles, California

News of Science

Rockefeller Institute Expands

The Rockefeller Institute will construct four new buildings with two gifts totaling $5 million that have been received from the estate of the late Alfred H. Caspary and from John D. Rockefeller, Jr. Three million dollars has been provided by the Caspary estate. It will be used for an auditorium, a graduate student residence hall, and a president's house.

The auditorium building, Alfred H. Caspary Hall, is now under construction. It includes an auditorium that will seat 500, six smaller auditoriums and conference rooms, and executive offices. A principal feature of the structure is a reinforced concrete dome, 90 feet in diameter and 40 feet high, which will be covered with brightly colored ceramic tile. The Caspary gift is the largest contribution ever made to the institute from outside the Rockefeller family.

The Rockefeller gift provides as much as $2.5 million for the construction and furnishing of a building to be known as Abby Aldrich Rockefeller Hall in memory of Mr. Rockefeller's first wife. The hall will serve as a social and residential center for scientists from all parts of the world who are visiting New York and for the institute faculty. The building will contain living quarters for 24 visiting scientists, two large social halls, a library, a refectory and smaller dining rooms, a music room, and a little theater.

Alfred H. Caspary Hall and Abby Aldrich Rockefeller Hall will fulfill four new functions in the development of the institute as an international science center.

1) Encourage scientists from all over the world to meet and live together for brief or extended periods of time in order to exchange ideas and synthesize important sectors of the rapidly accumulating mass of scientific knowledge.

Through the informal associations of scholars living together, information will be exchanged and new programs of research will be formulated in an environment of intense research activity. The new center has been especially planned to house conferences of eight or ten leading experts in a certain field of science, each assisted by a junior associate, who will live and study together for 3 or 4 months while preparing a monograph which will present a coordinated view of an important sector of science.

The informal exchange of knowledge and ideas should aid scientists to keep abreast of the rapid increase of scientific knowledge. The deliberations and conclusions of the extended conferences will be made widely available to those who are not specialists in the specialists' field.

2) Transmit scientific knowledge to young people and the general public as well as to students.

Because the welfare of peoples and of nations depend on a widespread understanding of science, the institute will assume a new responsibility for presenting scientific information and natural phenomena to school children, college students, and the general public. The laboratories of the institute will be the source of ideas and knowledge which will be described verbally by the faculty to audiences gathered in Caspary Hall. Experiments being prepared in the laboratories will be presented in the auditorium through the medium of closed-circuit television reaching out from the laboratories. In order to increase the size of the audiences many thousandfold, the lectures and the demonstrations will go out to a widespread audience by television, radio and sound films.

3) Provide ideal facilities for meetings of scientific societies in the closely related auditorium, meeting and conference rooms, and the social and residential quarters.

The center will provide a significant addition to the facilities of New York as a home of science and culture. The auditorium and meeting rooms of Caspary Hall will be supplemented by the social and housing facilities of immediately adjacent Abby Aldrich Rockefeller Hall with its extensive facilities for social gatherings, for dining, and for the informal associations which are so important an element in professional meetings. Close to mid-Manhattan, the United Nations, and New York's many cultural institutions, the center will be strategically located.

4) Encourage the cultural life of the institute faculty.

The Rockefeller Institute, like all the universities of New York City, has the advantages of the unsurpassed cultural resources of New York. It has the disadvantage, as do other urban universities, of dispersive commuting to remote suburbs. The center will seek to make the advantages more available to the faculty through exhibitions of paintings, programs of music, and lectures in many fields of the creative and performing arts. It will seek to mitigate the disadvantages by providing a social center for the faculty and their families.

Abby Aldrich Rockefeller Hall, Caspary Hall, and the 13-room president's house are scheduled for occupancy this summer.

Plans for the graduate residence hall are now in the process of development.

It will be designed to provide living quarters for 75 students and will also provide accommodations for married couples. A special feature of this dormitory will be temporary residential accommodations for graduate students from other universities who will be invited to the institute for brief periods of special study with members of the institute.

Theta Tau Discrimination Clause Causes Resignations

Two members of the Columbia University faculty, Wesley J. Hennessy, associate dean of the faculty of engineering, and Mario Salvadori, professor of civil engineering, have resigned from Theta Tau, professional engineering fraternity, because it bars Negroes from membership. The discriminatory clause in the fraternity constitution limits membership to white males.

In their letter of resignation, Hennessy and Salvadori say: "The reports of the Theta delegation to the national convention . . . clearly indicate that the fraternity as a whole is not ready to renounce the discriminatory clause and wishes to wait at least until 1958 before deciding upon this issue. To maintain such a clause in any constitution in the year 1957 is morally unacceptable."

Pomona Physics Building

Pomona College (Claremont, Calif.) has received an anonymous gift of $1 million for a new physics and mathematics building. Construction will begin this spring and the building will be occupied in September 1958. The new building's 40,000 square feet of floor space will more than double the space now available at Pomona for physics and mathematics instruction.

IBM Merit Scholarships

One of the largest industrial scholarship programs ever launched—calling for an average annual expenditure of approximately $250,000 when in full operation—has been announced by the International Business Machines Corporation. The program has been developed in honor of the late Thomas J. Watson, IBM board chairman, and will be known as IBM's Thomas J. Watson Memorial Scholarship Program. The National Merit Scholarship Corporation will cooperate in administering the program.

IBM's plan provides for 50 scholarships of 4 years each to be awarded annually on a competitive basis; 25 will go to high-school seniors who are children of IBM employees, and 25 to other high-school seniors in public, private, and parochial schools throughout the nation. This means that 4 years from now 200 students will be receiving benefits each year from the program.

In addition, a minimum of 25 matching scholarships will be awarded annually by the National Merit Scholarship Corporation. Each scholarship, whether awarded by IBM or National Merit, includes an equitable cost-of-education grant to the institution selected by the scholarship recipient.

Recipients will be selected on the basis of merit, without regard to financial need. The amount of the award, however, will vary from a minimum of $100 per year to the full cost of education and will be determined by the National Merit Scholarship Corporation on the basis of need.

Harvard Medical Center

Harvard Medical School and its seven teaching hospitals have incorporated themselves as the Harvard Medical Center, Inc., for the purpose of raising a common endowment fund. The charter of the new corporation states that its purposes are to "improve and advance knowledge, practice and teaching of medicine in all its branches; assist in the advance of medical research and investigation and in improvement of medical teaching facilities and methods; solicit and receive contributions from whatever sources in trust or otherwise and whether unrestricted or for undesignated purposes or subject to specified conditions."

In addition to the medical school, the center consists of the Harvard School of Dental Medicine, the Harvard School of Public Health, Beth Israel Hospital, Boston Lying-in Hospital, the Children's Medical Center, the Free Hospital for Women, Massachusetts Eye and Ear Infirmary, Massachusetts General Hospital, and Peter Bent Brigham Hospital.

George Packer Berry, dean of Harvard Medical School, is president of the center. The vice presidents are Ralph Lowell, a trustee of Massachusetts General, and Robert Cutler, chairman of the trustees of Peter Bent Brigham.

Lockheed Critical Assembly at Stanford

The Atomic Energy Commission has filed notice of the proposed issuance to Lockheed Aircraft Corporation of a permit for the construction of a critical experiments facility in Palo Alto, Calif. Announcement of the proposed issuance appeared in the *Federal Register* on 26 Feb. The permit will be issued unless, within 15 days of that date, a request for a hearing is filed with the commission.

A critical assembly differs from a reactor in that the arrangement of the fuel assembly and other components is not permanent but may be rearranged easily and quickly. The chain reaction is maintained at or near zero power, and little radiation is emitted. Assemblies of this sort are used to study the behavior of fissionable materials at various degrees of enrichment and in different shapes. Lockheed plans to use its facility primarily for testing reactor cores.

The Missile Systems Division of Lockheed Aircraft will build the facility on a 22-acre plot leased from Stanford University. The site is on the university's industrial research property, about 2 miles southeast of the Stanford campus.

The critical assembly building is to be an underground structure of reinforced concrete 40 feet from the nuclear physics building in which the control room will be located. Lockheed has indicated that the earliest date for completion of the facility is 31 Mar. 1957; the latest date, 30 Sept. 1957.

Britannica Films for Educational TV

The Westinghouse Broadcasting Company, Inc., which recently became the first commercial broadcaster to purchase the entire Encyclopaedia Britannica Films library for use on its television stations, is making selections from that library of 650 films available free to educational stations within the service areas of the Westinghouse stations.

Berkeley Basic Science Institute

The University of California has announced that its new Institute for Basic Science Research has started operations on the Berkeley campus with the appointment of eight faculty members to research professorships in the institute. The appointments will free the scientists from teaching and other university duties so that they may devote their entire attention to their research. It is expected that the institute will concentrate on a modest number of substantial projects—possibly ten—rotating among several fields and supporting some investigations that might have difficulty obtaining financial assistance from other funds.

The institute was established in 1955 with an endowment of nearly $2.75 million from an anonymous donor who provided that the institute "shall be dedicated to the encouragement of creative thought and the conduct of research and investigation in pure science. . . . The

primary purpose of the Institute shall be to discover and encourage the work of individuals of great talent and promise."

The university regents approved three professorships in the institute, effective 1 Jan.: Daniel Mazia, professor of zoology, for research on the life-history of the cell; Jerzy Neyman, director of the Statistical Laboratory, for research on the distribution of galaxies and expansion of the universe; and Stephen P. Diliberto, associate professor of mathematics, for research on stability of the moon's orbit and also on the three body problem.

Five more professorships will be effective on 1 July: G. H. Curtis and J. F. Evernden, both assistant professors of geology, who will continue work to establish geologic time correlation between continents and to set up a world-wide time scale by absolute dating of rocks, using the potassium-argon method; W. A. Nierenberg, professor of physics, for research in the hyperfine structural anomalies in cesium and rubidium; Roger Y. Stanier, professor of bacteriology, for research on photosynthetic pigments; and James Cason, professor of chemistry, for research on the electrochemical reduction and the chemistry of organo-phosphorus compounds. In addition, provision was made for the appointment of a visiting research professor of radio astronomy; a scientist for this post will be named later.

Initial appointments and grants have been made in the amount of approximately $170,000, including the payment of salaries and administrative and other costs. Under the terms provided by the donor, research professors and fellows will hold appointments for varying terms, not to exceed 5 years, unless the time is extended by a favorable vote of three-quarters of the regents of the university on recommendation of the Advisory Board.

The appointments reported so far will extend for periods of from 6 months to 2 years. In each case, the researcher holds an appointment in the institute comparable to his faculty post. When faculty members are appointed to temporary research professorships in the institute, their regular university salaries are to be made available to their departments to provide for replacements on the teaching staff.

The plans for the administration of the institute were drawn up by a committee of 12 faculty members headed by Chancellor Clark Kerr. The major organizational components of the institute are the Advisory Board and the Executive Committee.

The seven members of the Advisory Board include three scientists nominated by the National Academy of Sciences: Jerome Hunsaker, aeronautical engineer of the Massachusetts Institute of Technology; I. I. Rabi, Nobel laureate at Columbia University; and Paul Weiss, head of the laboratory of Developmental Biology of the Rockefeller Institute for Medical Research. Four Advisory Board members on the university staff are President Robert G. Sproul, chairman, *ex officio*; William R. Dennes, professor of philosophy; Glenn T. Seaborg, Nobel laureate and professor of chemistry; Curt Stern, professor of zoology. The Executive Committee is composed of the four University of California members, with Dennes as chairman.

Synthetic Racemic Material Available

CIBA Pharmaceutical Products, Inc., Summit, N.J., has made available to the Endocrinology Study Section, National Institutes of Health (Bethesda 14, Md.), its limited supply of *d,l*-aldosterone for biological and clinical investigation. This synthetic racemic material has one-half the biological activity of the natural *d*-aldosterone.

The synthetic material is available to qualified investigators in the following forms: *d,l*-aldosterone 21-monoacetate in a purified sesame oil solution (200 μg/ml and 20 μg/ml); *d,l*-aldosterone 21-monoacetate in a 95-percent ethanol solution (1 mg/ml); and *d,l*-aldosterone (nonesterified) in a 95-percent ethanol solution (10 μg/ml). The monoacetate will be distributed for biological work and the nonesterified form will be limited to use as a chromatographic standard. The alcohol solution of the monoacetate can be diluted for intravenous injections. Purified sesame oil can be obtained from CIBA for those who have occasion to dilute the oil solutions.

Requests should be made by letter to Dr. R. T. Hill, Executive Secretary, Endocrinology Study Section. The letter should state briefly exactly how much of the material is wanted and then describe the nature of the investigation in which it is to be used.

Tulane Apprenticeships in Zoology

The zoology and botany departments of Tulane University have instituted an apprenticeship program to provide entering freshmen with an opportunity to follow their interests in biology under guidance of the faculties in zoology and botany. Each apprentice will be assigned to a professor in the appropriate field. The student will devote 4 hours each week to a biological problem of his selection and will be encouraged to participate in departmental activities such as special lectures and graduate seminars. The program pays no stipend.

Population Reference Bureau

The Population Reference Bureau of Washington, D.C., has issued an invitation to graduate students to join its summer workshop. Candidates should be, preferably, students of demography, sociology, conservation, economics, or geography. Each member of the workshop will carry through his own research problem, from the bare statistics to a finished, interpretive essay.

When applying, candidates should explain how their major interest is related to population problems. Their applications should be supported by two letters from professors, instructors, or faculty advisers.

The 1957 session, the bureau's sixth annual workshop, will begin on 17 June and close on 26 July. Only six candidates will be chosen. They will receive $300 toward transportation and subsistence in Washington. Applications should be submitted *by 30 Mar.* to the Population Reference Bureau, 1507 M St., NW, Washington 5, D.C.

Intermittent Publications

One of the recommendations of the first International Congress on Documentation of Applied Chemistry, London, 1955, was "that National Centres to deal with Intermittent Publications be created." This question has been given careful consideration by the Ad Hoc Committee on Abstracting and Documentation of the International Union of Pure and Applied Chemistry, under the chairmanship of H. R. Kruyt.

The committee was of the opinion that it would be inadvisable to stimulate the creation of new national bodies for this kind of documentation. It was, however, decided to write to each of the national adhering bodies of the union asking them about the present position with regard to the documentation of such publications in their countries. The term *intermittent publications* has been defined as documents which are not books in the ordinary sense and not regular periodicals; they may be printed, offset, mimeographed, photographed, or even typewritten; they comprise reports, monographs, symposia, surveys, conference papers, data sheets, students' theses, standard specifications, test specifications, bulletins, technical papers, circulars, leaflets, and memoranda.

Of the 30 or so countries queried, 17 have sent replies varying considerably in length and comprehensiveness. The following is an attempt to summarize the present position on the basis of the replies received.

All the national adhering bodies recognize the size of the task. Yugo-

slavia merely states that some action would be useful, whereas Spain and Colombia are willing to pursue the matter further. Australia and Sweden say that the question is already being discussed by organizations in their respective countries, while certain other countries—namely, Belgium, Canada, Czechoslovakia, and Denmark—state frankly that the problem is too vast to be solved as a whole, although certain types of intermittent publications, for example, university doctorate theses in Belgium, are now being documented.

However, according to Hungary, Norway, Finland (in part), India, and Japan, national intermittent publications are already documented; Japan is willing to take steps to make the documentation complete. Great Britain considers that nearly everything of importance finds its way into a recognized publication and is therefore documented in the usual way.

This opinion is not shared by Canada, who suggests that few, if any, intermittent publications ever appear in the abstract journals. France considers it sufficient that all publications must be deposited in the National Library and that the CNRS endeavors to document everything of importance. The Austrian reply was concerned with the production of intermittent publications by scientific societies rather than with their documentation.

It is obviously unwise to try to draw any general conclusions when only 17 national adhering bodies have replied, but the information obtained so far shows such a great diversity of approach to a common problem, that it seemed useful as an interim indication of the kind of information that the committee is collecting.

Darbaker Prize in Phycology

The Darbaker Prize Committee of the Botanical Society of America will accept nominations for an award to be announced at the annual meeting of the society in 1957. Under the terms of the bequest, the award is to be made for meritorious work in the study of the algae, particularly the microscopic algae. The value of the 1957 prize will depend on the income from the trust fund that supports it, but the amount is expected to be about $150.

The committee will base its judgment primarily on the papers published by the candidate during the last two full calendar years previous to the closing date for nominations. Only papers published in the English language will be considered.

Nominations for the 1957 award, accompanied by a statement of the merits of the case and by reprints of the publications supporting the candidacy, should be sent *before 1 May* to the chairman of the prize committee, George F. Papenfuss, University of California, Berkeley, Calif.

NSF Funds Available

The Division of Biological and Medical Sciences of the National Science Foundation has announced that the next closing date for receipt of research proposals in the life sciences is *15 May*. Proposals received after the May closing date will be reviewed following the fall closing date of *15 Sept*.

In addition to funds for the support of basic research in the life sciences, limited funds will be available during the current fiscal year for the support of research facilities and programs at biological field stations. Inquiries should be addressed to the National Science Foundation, Washington 25, D.C.

Microfilm Cameras for Libraries

A new microfilm camera that has been developed by Atherton Seidell and H. F. Flemer is being given free to research libraries on condition that the libraries substitute microfilms for interlibrary lending of original publications. Flemer is a specialist in microfilms who is in charge of the photoduplicating service of the U.S. Department of Agriculture. Seidell, to whom inquiries should be addressed, can be reached at 2301 Connecticut Ave., NW, Washington, D.C.

With the new microfilm camera the illumination, time of exposure, aperture of the lens, and development of the exposed film are all definitely fixed in advance, so that no adjustments of the unit are needed to get good microfilms of the usual library publications. Microfilm copying may therefore be performed by library employees who have had very little special training. Seidell and Flemer also have developed a small inexpensive microfilm viewer.

Taxonomy of the Actinomycetes

The Society of American Bacteriologists, through its Subcommittee on the Taxonomy of Actinomycetes, has received grants from industry to support fundamental research on the taxonomy of actinomycetes. The aim of the program is to foster research in this field and to encourage the training of people in the taxonomy of this group. The ultimate objective is to stimulate the publication of monographic treatments of the actinomycetes and the unification of this material for a system of identification. The companies that have so far made financial contributions to the project are Abbott Laboratories; Bristol Laboratories, Inc.; Chas. Pfizer and Company, Inc.; Eli Lilly and Company; Lederle Laboratories; Merck Sharp and Dohme; Parke, Davis and Company; and Upjohn Company.

The committee would welcome requests for support of work that deals with a phase of actinomycete taxonomy. Applications should be sent to the temporary chairman of the committee, Prof. K. L. Jones, Department of Botany, University of Michigan, Ann Arbor, Mich.

Fishery Studies

Under the provisions of the Fish and Wildlife Act of 1956, the funds allotted for market, technologic, and biological research and for the development of American commercial fisheries has been increased by almost $3.6 million. With the $3 million currently allotted for this work, the total now available for the fiscal year ending 30 June 1957 is almost $6.6 million. The sum will be administered by the Bureau of Commercial Fisheries in the Department of the Interior.

History of Science Prize

An annual award of $250 has been established by Henry and Ida Schuman of New York for an original prize essay in the history of science and its cultural influences. This competition is open to undergraduate and graduate students in any American or Canadian college, university, or institute of technology. Papers submitted for the competition should be approximately 5000 words in length, exclusive of footnotes, and thoroughly documented. It is hoped that the prize-winning essay will be suitable for publication in *ISIS*, the journal of the History of Science Society.

It is the wish of the donors that "history of science and its cultural influences" should be broadly interpreted. The papers—which should in each case be original contributions to learning—may deal with the ideas and accomplishments of scientists in the past; they may trace the evolution of particular scientific concepts; or they may study the historical influences of one branch of science upon another.

The phrase "cultural influences" is taken to include studies of the social and historical conditions that have influenced the growth of science, or the effects of scientific developments upon society in the realms of philosophy, religion, social

thought, art and literature, economic progress, and so forth. Essays dealing with medical subjects are not acceptable, although papers dealing with the relations between medicine and the natural sciences will be welcomed.

Papers submitted for competition should be sent *before 1 June* to the chairman of the prize committee, Prof. Harry Woolf, Department of History, University of Washington, Seattle 5, Washington. The announcement of the prize-winning essay will be made at the annual meeting of the History of Science Society, which occurs in December each year.

Atomic Insurance

Protection up to $60 million against liability and personal property damage claims will be provided for each atomic energy unit in the country by the three insurance syndicates. The syndicates are the Nuclear Energy Property Insurance Association, which will provide maximum coverage of about $60 million for each reactor unit; the Nuclear Energy Liability Insurance Association, which will grant coverage to those eligible for personal liability insurance up to about $50 million; and a third syndicate now nearing completion, which will issue up to $15 million to cover both personal and property liability arising from any possible incidents that might be attached to the operation of private nuclear facilities.

Although the syndicates will provide the necessary basic coverage for atomic insurance, additional protection is needed. The cost of a catastrophic accident might be considerably higher than $60 million. A bill now on the Congressional calendar calls for the United States to pay, in return for a reasonable charge to the atomic energy units, up to $500 million for damages above the amount covered by private insurance.

Nomenclature of Cultivated Plants

Dissension over the provisions of the current edition of the *International Code of Nomenclature of Cultivated Plants (1952)* has prompted the International Union of Biological Sciences to activate its International Commission on the Nomenclature of Cultivated Plants. The commission is composed of eight representatives each of horticulture, agriculture, and forestry, plus a chairman and rapporteur général. American members of the commission, which held its first meeting in Utrecht, 22–24 Nov. 1956 under auspices of IUBS, are Martin Weiss (agriculture) U.S. Department of Agriculture, Elbert L. Little (forestry) U.S. Bureau of Forestry, and George H. M. Lawrence (horticulture) Bailey Hortorium, Cornell University.

Scores of proposals for changes in the present code had been studied previously and were voted on at this session. Paramount among the decisions adopted unanimously was that to retain the name *cultivar* as the international term for all cultivated variants (reserving the technical term *varietas,* and its abbreviation *var.,* for the well-known botanical category), and to authorize use of the alternate term in various national languages (such as *Sorte* in German, *razza* in Italian, and *variety* in English).

The commission agreed on the need for a single code for all concerned with cultivated plants and took steps to simplify the present one. Ample opportunity will be provided all interested groups to study the new edition now in preparation, following which it will be submitted to several international bodies for endorsement and adoption. Persons desiring further information on the work of this commission or wishing to submit proposals for its consideration are invited to communicate with the secretary, Dr. Harold R. Fletcher, Royal Botanic Garden, Edinburgh, Scotland, or any one of the aforementioned American representatives.

Union Carbide Nuclear Research Center

Plans for the construction of a nuclear research center in Sterling Forest, New York (about 40 miles from New York City) have been announced by the Union Carbide and Carbon Corporation. The major facilities on the site will include: a 5-megawatt pool-type reactor, a radioactive materials laboratory, an ores and engineering laboratory, and a building for allied research operations and administrative functions. The architect-engineer for the center is the Osborn Company in Cleveland, Ohio.

The center will be operated jointly by the Union Carbide Nuclear Company and Union Carbide Ore Company, two of the corporation's divisions. It will serve as the focal point for nuclear research activity within Union Carbide. Research programs will be geared to the study of the effects of radiation on products and processes involving plastics, gases, metals, carbons, and chemicals.

The research reactor will be a modified version of the bulk-shield testing facility pioneered by Oak Ridge National Laboratory. Smaller reactors of this type have been installed at several colleges throughout the country. The Union Carbide reactor will be designed and built by AMF Atomics, Inc., a subsidiary of American Machine and Foundry Company. A formal request for the construction permit has been submitted to the U.S. Atomic Energy Commission for approval. Completion of the research center is scheduled for late 1958 or early in 1959.

Avco Laboratory

Avco Manufacturing Corporation has started work at Wilmington, Mass., on its $15-million Research and Advanced Development Division. The facility will serve all the corporation's research and development programs and also will undertake specific projects for private research laboratories and teams. The center is expected to be in full operation by mid-1958.

Tissue Culture Fellowships

Fellowships for short courses in tissue culture are being offered by the National Foundation for Infantile Paralysis. Postdoctoral investigators and teachers and graduate students, as well as experienced laboratory personnel with the baccalaureate degree, are eligible to apply. The latter should be currently employed in a laboratory position and have the intention of utilizing this experience in tissue culture in a specific laboratory position upon completion of the course.

Fellowships may be used only to support study in formal courses designed to teach the principles, techniques, and application of tissue culture. Funds will be awarded for the period necessary to complete such a course, but in general the time is not expected to exceed 6 weeks.

Financial assistance will be based on the individual applicant's need. For application forms and further information, write to the Division of Professional Education, National Foundation for Infantile Paralysis, 120 Broadway, New York 5, N.Y.

Positions in IGY Tracking Program

The Astrophysical Observatory of the Smithsonian Institution, 60 Garden St., Cambridge 38, Mass., is accepting applications from scientists and technicians for positions in the Optical Satellite Tracking Program of the International Geophysical Year. Qualified personnel will be assigned as observers to IGY stations in the United States and in foreign countries for periods of from 1 to 2 years. Prior experience in physics, astronomy, or electronics is mandatory and an academic degree in one of these fields is desirable. Interested persons should write to the Associate Director, Satellite Tracking Program at the address given earlier.

Sewage Disposal

The U.S. Public Health Service has announced that grants totaling $3,883,535 have been made to 60 municipalities to help build sewage treatment works under the new Federal Water Pollution Control Act. The 60 cities and towns, ranging from 280 to a quarter of a million in population, added $11,870,688 of their own funds to bring the cost of the sewage treatment facilities to a total of $15,754,223.

Last summer Congress authorized federal grants of $50 million a year (up to an aggregate of $500 million) for the construction of municipal sewage treatment works. It limited individual grants to $250,000, or 30 percent of the total cost of the project, whichever is less.

Scientists in the News

PETER WATERMAN, an electrical engineer at the Naval Research Laboratory, Washington, D.C., recently received the Distinguished Civilian Service award from Garrison Norton, Assistant Secretary of the Navy for Air. His citation read: "Through his exceptional leadership, initiative, and scientific ingenuity, Waterman has contributed outstandingly to the improvement of the combat effectiveness of the Navy. He has taken a leading and decisive part in a program to improve interceptor aircraft armament control systems. . . ."

JOHN J. BITTNER, George Chase Christian professor of cancer research and director of cancer biology in the department of pathology at the University of Minnesota Medical School, has won the 1957 Bertner award of the University of Texas M. D. Anderson Hospital and Tumor Institute. The award is presented annually for outstanding contribution to the field of cancer research.

Bittner received the award on 8 Mar. at a banquet, after which he delivered the Bertner Foundation lecture before participants and guests of Anderson Hospital's eleventh annual Symposium on Fundamental Cancer Research. The title of the lecture was "Studies on mammary cancer in mice and their implications for the human problem."

Bittner was honored for his research on the factors involved in the origin of mammary cancer in mice. Beginning with investigation and discovery of the milk factor in relation to cancer, he proved that inheritance was not the sole cause of the origin of the neoplasm and that a virus was implicated in its origin. Continuing his research he investigated genetic and hormonal factors, proving that interaction of these two, along with the virus or milk factor, was required for the development of this type of cancer in mice. Bittner's work has lead to many and varied investigations of the cause, development, and course of cancer.

JOSEPH L. MORSE, formerly associate professor of dermatology at the New York Post-Graduate Medical School, New York University–Bellevue Medical Center, has been appointed professor and director of the department of dermatology of the New York Medical College, and its affiliated hospitals, Flower–Fifth Avenue, Metropolitan, and Bird S. Coler.

ROBERT E. ROBINSON, SR., who for the past 5 years has been chief research engineer and geologist for Trans-American Petroleum Corporation, Shreveport, La., has established a laboratory in Shreveport to enter private consulting practice. His work will cover reservoir engineering and geology, well completion engineering, and production engineering.

ROGER REVELLE director of the Scripps Institution of Oceanography in La Jolla, Calif., has been awarded an honorary degree by Pomona College in recognition of his contributions to deep-sea research.

WALTER G. DRISCOLL has been named vice president in charge of research at Baird-Atomic, Inc., Cambridge, Mass. Driscoll, formerly director of research for Baird-Atomic, will continue to supervise the company's basic and applied research programs. Baird-Atomic, Inc., is the new corporate name of Baird Associates–Atomic Instrument Company. The firm manufactures spectrochemical and radioactivity instrumentation, as well as electronic counting, control, and test devices.

M. CARL WALSKE, who recently left the Los Alamos Scientific Laboratory to join Atomics International, Canoga Park, Calif., a division of North American Aviation, Inc., has been named assistant chief of research at Atomics International. In his new post, Walske is concerned with the theoretical and experimental nuclear physics research programs.

Two appointments that will become effective on 1 Sept. have been announced by the University of Cincinnati. HOWARD K. JUSTICE, professor of mathematics, will become dean of the College of Engineering, and CORNELIUS WANDMACHER, professor of civil engineering, will become associate dean. Justice succeeds C. ALBERT JOERGER, who will retire next summer.

EUGENE M. K. GEILING, chairman of the department of pharmacology at the University of Chicago, has retired. LLOYD J. ROTH, who joined the department in 1952, is his successor. Geiling has been the Frank P. Hixon distinguished service professor since 1941, and professor and chairman of pharmacology since 1936.

He developed the first "atomic farm" for the production of radioactive plant drugs, such as digitalis and morphine. He is widely known for his studies of the pituitary glands, and early in his career participated in the research with John J. Abel of Johns Hopkins University which led to the crystallization of insulin. Now that he is professor emeritus, Geiling will write a biography of Abel, who is often called the father of modern experimental pharmacology in the United States.

During the 1930's Geiling led a team of scientists that worked at Canadian whaling stations obtaining the pituitary glands from freshly captured whales. This research proved that oxytocic, pressor, and antidiuretic hormones come from the neural lobe of that gland and not the intermediary lobe as was then believed. During World War II, Geiling led his department at Chicago in projects on the study of war gases and malaria drugs.

Geiling was born of German parents in Brandfort, Orange Free State, South Africa. He received his B.A. degree in 1911 from the University of South Africa; his graduate study was at the University of Illinois, which awarded him an M.S. degree in 1915 and a Ph.D. in 1917.

He returned in 1918 to South Africa to lecture at the Potchefstroom Agricultural College and the University of Capetown College of Medicine. He came to the U.S. again in 1920 to take a Seesel research fellowship in physiological chemistry at Yale University. He worked with Abel at Johns Hopkins from 1921 to 1936, taking his M.D. degree (1923) there and advancing from assistant to associate professor in pharmacology. In 1936, Geiling was appointed full professor and chairman of the newly created department of pharmacology at the University of Chicago.

Among the awards he has received are the Oscar B. Hunter memorial award of the American Therapeutic Society and Villanova College's Mendel gold medal for outstanding research in the endocrines of aquatic mammals. In 1940 he was elected president of the American Society for Pharmacology and Experimental Therapeutics; in 1948 he was elected president of the Society of Experimental Biology and Medicine; in 1928 he was appointed chairman of the Section on Experimental Medicine and

Therapeutics of the American Medical Association; and in 1956 he was elected president of the Albertus Magnus Guild of Catholic Scientists.

J. R. WOLFF, who has been with Argonne National Laboratory since 1949, is now director of research at the Radiation Instrument Development Laboratory, Chicago, Ill. His responsibilities will include correlating the laboratory's engineering and development activities with those of Intertechnique of Versailles, France, which manufactures R.I.D.L. equipment.

MILTON ORCHIN, professor of chemistry and acting chairman of the department of chemistry at the University of Cincinnati, has received the eighth annual "Eminent Chemist" award of the Cincinnati section of the American Chemical Society.

CARL F. J. OVERHAGE has been appointed director, and WILLIAM H. RADFORD associate director, of Lincoln Laboratory at Massachusetts Institute of Technology. Both men have been division heads at Lincoln. They succeed, respectively, MARSHALL G. HOLLOWAY and GEORGE E. VALLEY, who have resigned. Holloway will go to a new position in industry, and Valley, promoted from associate to full professor of physics, is returning to faculty service on the M.I.T. campus in Cambridge.

Another appointment at M.I.T. is that of CLAUDE E. SHANNON, who will have the dual title of professor of communications sciences in the department of electrical engineering and professor of mathematics. For the past year Shannon has been visiting professor of electrical communications, while remaining a research mathematician on the staff of Bell Telephone Laboratories. He will continue collaborative work with Bell. Shannon has achieved special eminence in the field of information theory, a new science which combines the methods of mathematics and electrical communications in computing, automation, and areas of the behavioral sciences that bear on the relation of man to his environment.

FRANK W. HURD has been appointed director of research for the Union Carbide Nuclear Company, a division of the Union Carbide and Carbon Corporation. Hurd has been identified with the corporation's activities in the atomic energy field since 1943, when he joined the Manhattan Engineering District project at Columbia University as a senior research scientist. In 1955 he was appointed superintendent of research and development, industrial applications, for Union Carbide Nuclear Company.

NORMAN HILBERRY has been named director of Argonne National Laboratory of the University of Chicago, which operates the laboratory for the U.S. Atomic Energy Commission. Deputy director of Argonne since it was established in 1946, Hilberry succeeds WALTER ZINN, who resigned last June.

The Wagner Free Institute of Science, Philadelphia, Pa., has selected three scientists for this year's Westbrook Free Lecture series, which is entitled "Scientific progress and human needs." The lecturers will discuss the subject from the standpoint of human ecology, the present and future contributions of chemistry, and the future development of solar energy.

The following scientists have accepted invitations to participate: 4 Apr., WILLIAM VOGT, national director, Planned Parenthood Federation of America, "The structure of survival"; 11 Apr., GEORGE R. SEIDEL, technical adviser, E. I. Du Pont de Nemours and Company, "The one best way"; and 18 Apr., MARIA TELKES, project director, New York University, "The uses of solar energy."

G. ROBERT GREENBERG, associate professor of biochemistry at Western Reserve University, has been appointed professor of biological chemistry at the University of Michigan. During the past year he has served as a senior National Science Foundation fellow, working at Kings College in England.

ALMA HILLER has retired from his positions as associate attending biochemist in charge of clinical chemistry at Presbyterian-St. Luke's Hospital, Chicago, Ill., and associate professor of biological chemistry at the University of Illinois College of Medicine.

RCA Laboratories, Princeton, N.J., has announced that ROLF W. PETER has been appointed director of the Physical and Chemical Research Laboratory, and ALLEN A. BARCO, director of the Systems Research Laboratory. Peter, research physicist at the laboratories since 1948, succeeds HUMBOLDT W. LEVERENZ, who has been named assistant director of research, RCA Laboratories. Barco, who has been engineer-in-charge of the Industry Service Laboratory at the David Sarnoff Research Center, succeeds GEORGE H. BROWN, who has been appointed chief engineer, RCA Commercial Electronic Products.

JOHN H. MELVIN, state geologist of Ohio since 1947, has been elected vice president for operations of the Pennsylvania Drilling Company of Pittsburgh.

GEORGE M. AUSTIN of Philadelphia, Pa., will become the first full-time head of the division of neurosurgery at the University of Oregon Medical School. He will succeed JOHN RAAF, who has been advanced to clinical professor of surgery and senior consultant in neurosurgery. Austin practices neurosurgery in Philadelphia and holds an appointment as assistant professor of neurosurgery at the University of Pennsylvania Medical School. He will assume his new position on 1 July.

Recent Deaths

CHARLES S. CARLETON, Suffield, Conn.; 84; former professor of civil engineering at Norwich University; 21 Feb.

SAMUEL W. CROLL, Bernardsville, N.J.; 67; mechanical engineer; 26 Feb.

ELMER A. HOLBROOK, Pittsburgh, Pa.; 75; former dean of the school of engineering at the University of Pittsburgh; 20 Feb.

UBERT C. HOLLAND, New Brunswick, N.J.; 67; professor emeritus of engineering drawing at Rutgers University; 26 Feb.

JOHN H. HOSKINS, Cincinnati, Ohio; 61; head of the department of botany at the University of Cincinnati; 8 Feb.

JOHN A. KING, Jr., Verona, N.J.; 60; retired research engineer at the Radio Corporation of America's tube division; 22 Feb.

ERNST KRIS, New York, N.Y.; 56; psychoanalyst and faculty member of the New York Psychoanalytic Institute and the Child Study Center at Yale University; 27 Feb.

HOWARD H. LONG, Wilberforce, Ohio; 69; dean of Central State College; 21 Feb.

JOHN F. MAHONEY, Arrocha, N.Y.; 67; director of the bureau of laboratories in the New York City Department of Health and former Health Commissioner of New York; 23 Feb.

GEORGE F. STRONG, Vancouver, B.C., Canada; 60; president of the National Heart Foundation of Canada; 26 Feb.

FRED W. TANNER, Winter Park, Fla.; 69; former head of the department of bacteriology at the University of Illinois; 24 Feb.

JAMES P. WARBASSE, Woods Hole, Mass.; 90; surgeon, author, and leader in the cooperative movement who also is credited with having set up the first laboratory of surgical pathology and bacteriology in America at Methodist Hospital in 1892; 22 Feb.

MILTON WASCH, Brooklyn, N.Y.; 72; former clinical professor of radiology at the Long Island College of Medicine; 22 Feb.

Reports

Growth-Inhibiting Effect of Irradiated Tryptophan

In an attempt to obtain competitive inhibitors, we have exposed crystalline L-tryptophan (*1*) to radiation (10^9 rep) produced by high-velocity electrons from a modified 1 Mev resonant-transformer-type x-ray unit previously described by Knowlton *et al.* (*2*). Care was taken to avoid increase in temperature above 65°C during the exposure. Chromatographic studies following exposure showed that a number of compounds were produced. None of these compounds have as yet been identified.

The irradiated tryptophan was placed in 100-percent methanol, and only the methanol-soluble fraction was used for microbiological studies. Varying amounts of this fraction were placed in test tubes, and the methanol was evaporated. To the residue was added 10 ml of tryptophan assay medium (*3*) containing 10 μg of untreated L-tryptophan.

Following sterilization for 15 minutes at 120°C, the test tubes were inoculated with (i) *Streptococcus mastitidis* V_9, (ii) *Streptococcus mastitidis* 68Cl, and (iii) *Lactobacillus arabinosis* 17-5. The bacterial cells had been washed twice with physiological saline and then diluted, so that the final suspension was only faintly cloudy. One drop of the bacterial suspension was added to each of the test tubes, which were then incubated for 18 hours at 37°C. Growth at the end of this period was recorded as 0 (no growth) to 4 (complete growth as in the control tubes).

We found that the irradiated tryptophan contained one or more compounds that were capable of inhibiting the growth of *Streptococcus mastitidis*. We also found that this inhibition could be overcome by addition of untreated L-tryptophan. Following these preliminary experiments, the methanol-soluble fraction was run through Al_2O_3 columns as described by Bumpus and Page (*4*). It was found that the first fractions passing through this column contained the inhibiting compounds.

To obtain more of the inhibitor and to study its adsorption properties, we extracted 20 g of irradiated L-tryptophan with methanol, concentrated the extracts to about 120 ml, filtered off some precipitated tryptophan, and poured the solution onto a column, 8 cm high by 9.5 cm in diameter, of Al_2O_3. The column was then washed with methanol. After the void volume of the column had been discarded, 22 fractions of filtrate (20 ml each) were collected. Tests of these fractions showed that all gave negative ninhydrin tests for α-amino acid. Fractions 6 to 14 showed positive tests for the α-unsubstituted indole nucleus with Ehrlich's reagent, and fractions 4, 5, and 6 contained an inhibitor for the growth of *Streptococcus mastitidis*. The dried solutes from fractions 1 to 22 varied considerably in odor, color, tarriness, and fluorescence. Previous chromatographic experiments had shown that no more inhibitor could be obtained by continuing the elution further with aqueous methanol.

The fractions containing the inhibitor (fractions 4, 5, and 6) were combined and extracted with acetone, and the extracts were poured onto a 35- by 180-mm column of silicic acid. The column was washed with 900 ml of acetone, followed by two 300-ml portions of 4/1 (by volume) acetone and methanol, followed by three 300-ml portions of 1/1 acetone and methanol. Only the first eluate fraction (4/1 acetone and methanol) contained the inhibitor, which showed a considerable effect upon growth of *Streptococcus mastiditis* V_9 and only a slight effect on *Lactobacillus arabinosis*. The inhibition could be overcome by addition of tryptophan to the cultures in amounts equal to, or in excess of, the weight of the inhibiting fraction.

The active fraction weighed 40 mg and was obtained in a very impure form amounting to less than 0.2 percent of the irradiated tryptophan. The fraction showed inhibiting effects on the following microorganisms: *Leuconostoc mesenteroides* 8042, *Escherichia coli* B/r, and *Staphylococcus aureus* P60; it showed no inhibiting effects upon *Streptococcus lactis* L21S, *Bacillus subtilis* S8, *Aerobacter aerogenes* 600, and *Sarcina*.

The following compounds were tested and showed no growth-inhibiting effects on *Streptococcus mastitidis*: indene, indolepropionic acid, phenol indophenol, *p*-aminoacetophenone, and indoleacetic acid. Experiments with other irradiated amino acids indicated the presence of growth-inhibiting compounds, especially in irradiated L-arginine, L-phenylalanine, and L-serine. We are now attempting to purify the compounds produced in these amino acids. We have been unable to produce growth-inhibiting fractions by prolonged exposure of L-tryptophan to ultraviolet radiation.

The active fraction obtained by passing irradiated tryptophan through Al_2O_3 and silicic acid columns is undoubtedly a mixture of compounds. We have not yet been able to isolate and identify the compound that inhibits the growth of *Streptococcus mastitidis*. Possibly there may be several compounds. It will be of interest to study the effects of the fractions obtained from irradiated amino acids on mammalian cells, both *in vivo* and in tissue cultures. Such studies are now under way (*5*).

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5. We wish to thank J. S. Balwit for the radiation services required in this work and R. M. Mendenhall for chromatographic studies.

26 December 1956

Photoperiod and Chilling Control Growth of Hemlock

Eastern hemlock, *Tsuga canadensis* (L.) Carr., illustrates to an unusual degree the influence of photoperiod on the annual vegetative cycle of trees. Short nights not only prolong stem growth by delaying the formation of terminal buds but also result in a striking compensation for lack of chilling in the breaking of bud dormancy. These environmental effects apply throughout the range of this important forest tree, from the low southern Appalachian region to Canada, although they are modified by genetic differences that adapt ecotypes to con-

All technical papers and comments on them are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table *or* one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in *Science* 125, 16 (4 Jan. 1957).

trasting climates. Previous brief announcements of these conclusions (*1*) are supported by the following basic experiment and by later extensions that are summarized in subsequent paragraphs.

To study the breaking of bud dormancy, 2-year-old wild seedlings from near New Haven, Conn., were handled in four groups as follows: (i) one group was potted 1 Dec. 1952 after exposure to cool autumn weather and then kept in the greenhouse under natural short-day, long-night conditions; (ii) the second group was potted in early October 1952, before frost, but later was chilled indoors at 5° C for 5 to 15 weeks; (iii) the third group was potted in October as in group ii but was maintained in the greenhouse without chilling on a natural short-day, long-night cycle; (iv) the fourth group received treatment similar to that of group iii, except that supplementary incandescent light less than 200 lux reduced the dark period to 4 hours out of 24.

Buds on all chilled plants in groups i and ii promptly began growing when the seedlings were returned to favorable temperatures. Of the unchilled plants, none of those on long nights (group iii) opened their buds, while many on short nights (group iv) did so. This suggests the presence of bud dormancy, normally broken by brief chilling, and possible compensation for lack of chilling by short nights.

More detailed effects were shown by groups (ii) and (iii) after 9 Mar. 1953, when plants were moved to a 24°C (±2°) growth room with different photoperiods. The plants treated with a short day and long night received 8 or 12 hours of continuous fluorescent light (4000 lux) followed by 16 or 12 hours of total darkness, respectively. Those treated with a long day and short night received 16 hours of light (3000 lux) followed by 8 hours of darkness or exposure to dim incandescent light (less than 200 lux) for 4 to 8 hours. The durations of total darkness were consequently 8, 4, or 0 hours, respectively.

Unchilled plants (group iii) on long nights still failed to break dormancy; those on short-night treatments (except for a few diseased plants) broke dormancy within 5 to 14 weeks (Fig. 1*A*). This all-or-none difference is a more drastic interaction of photoperiod and chilling in woody plants than most reports have previously indicated (*2*). Nevertheless, photoperiod only partially compensates for lack of chilling, as was shown by the number of weeks required for all buds to break dormancy (circled numerals in Fig. 1*A*). The period necessary was 2 to 3 times as great for unchilled plants on short nights as for chilled plants under the same conditions.

All the chilled plants (group ii) broke dormancy on all photoperiods within 3 to 5 weeks after removal from 5°C storage, regardless of the length of the chilling period (Fig. 1*A*).

Continued observation of chilled plants (group ii) showed that all those on long nights formed new buds within 10 weeks, whereas both chilled plants (group ii) and unchilled plants (group iii) which were under the short-night condition continued growth until at least the 15th week and then only gradually began forming buds (the boxed numerals in Fig. 1*B* indicate the number of weeks required for *all* plants to form buds). The 4-hour night produced noticeably greater elongation than either an 8-hour night or continuous light, as has been found also for elongation in Scotch pine (*3*). In hemlock, as in many other trees that do not have determinate growth, the amount of elongation is strongly conditioned by the length of the period of meristematic activity (*2–4*).

To show that duration of the light period is not the sole factor responsible for elongation, supplementary treatments were made by interrupting the dark periods of additional plants which had only short-day illumination at high intensity with dim incandescent light (less than 200 lux) as follows.

The 12-hour dark period was interrupted after 4 hours by subjecting the plants to 4 hours of incandescent light (4+4, Figs. 1*A* and 1*B*). The 16-hour dark period was interrupted after 4 hours by 2 hours of dim light followed by 4 hours of total darkness, then another 2 hours of dim light, and finally another 4 hours of total darkness (4+4+4, Figs. 1*A* and 1*B*). Short-day treatments with several short dark periods gave results comparable with those of the normal long-day, short-night treatments rather than with the combinations of short days with uninterrupted long nights. This was true both for the breaking of dormancy by the photoperiodic compensation for lack of chilling and for the delay in formation of terminal buds. The duration of the dark period controls the growth of other tree species (*3, 5*) and governs many other photoperiodic responses (*6*).

Other experiments (*6*) confirmed many of the present results and showed further the following. (i) The greatest difference in response came with about 8- and 9-hour nights, rather than with 10-, 11-, or 12-hour dark periods, for 30 seed sources from the area of Tennessee and North Carolina north to Nova Scotia and west to Minnesota. (ii) Seedlings with parents from areas with short growing seasons (about 100 days) went dormant progressively earlier than those from long-season regions (up to nearly 200 days), for each of 17 photoperiodic

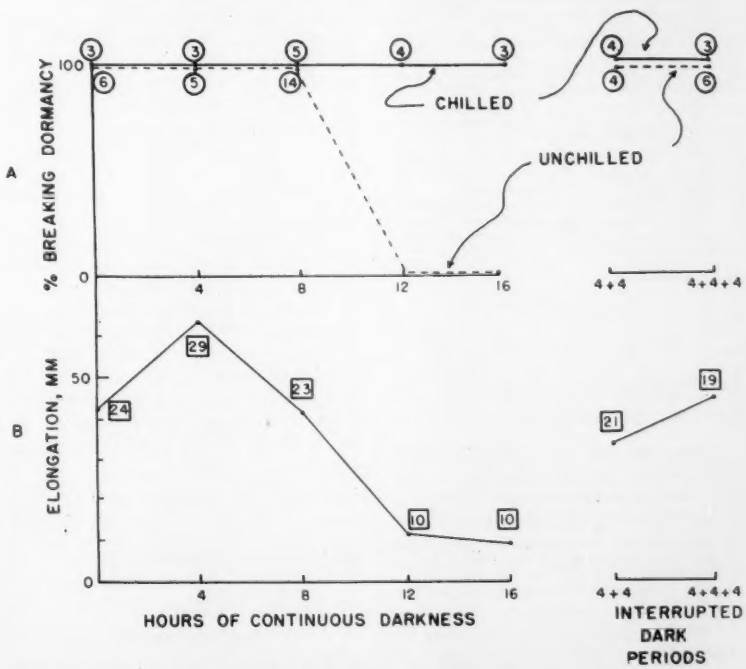

Fig. 1. Chilling and photoperiod as related to breaking of dormancy (*A*) and return to dormancy (*B*). The circled digits indicate the number of weeks required for all healthy plants to break dormancy. The boxed digits indicate the number of weeks required for all plants to return to dormancy.

and thermoperiodic treatments (compare Wareing, *4*). (iii) In forest and nursery plantings near New Haven, Conn., as indoors, long-season ecotypes grew faster than northern or mountain types, but this advantage was partly canceled by injury from early frost. (iv) Seed with 10 weeks or more of moist chilling germinated well at 12° and 17°C with either 0, 8, 12, or 16 hours of light, but, at higher temperatures or shorter periods of stratification, the photoperiod had a marked influence; optimal length of day for germination seemed to be longer at 27° than at 17°C (*7*).

The responses of seed and seedlings to light and temperature are pertinent to basic physiological problems of morphogenesis and to field ecology, forestry, and horticulture of *Tsuga* and other trees.

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7. F. W. Stearns and J. S. Olson, in preparation.

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23 November 1956

Studies with Muscle Relaxant Labeled with Iodine-131

A search has been made for compounds that produce neuromuscular block and that can also be labeled with iodine-131 so that their movements in muscle may be studied in conjunction with their pharmacological effects (*1*). The compound, decamethylene 1,10-bis(2-iodoethyl dimethyl ammonium) dichloride has been prepared (*2*), and this may be regarded as a substitution product of decamethonium; it has been termed "iodocholinium." This compound resembles decamethonium in its action on the isolated guinea pig diaphragm. Decamethonium is known to produce an initial neuromuscular block which is followed by some recovery and the development of a slow secondary block that takes at least 3 hours for completion (*3*). Iodocholinium acts similarly but more slowly. In doses of 3 μg/ml, it gives a slow block which is still increasing even after 12 hours.

The uptake of the drug was studied by soaking diaphragm muscles from guinea pigs in saline containing subparalytic (3 μg/ml) doses of labeled compound, the muscles being removed at intervals for analysis. The temperature was 38°C, and the saline was renewed frequently. Radioactivity of the muscles expressed in counts per minute, per gram increased continuously for at least 12 hours, and this is consistent with the pharmacological findings. The uptake was surprisingly high, and it corresponds, after 1 hour, to 2.5 μg/g of muscle. After 12 hours it had reached 14 μg/g, and this indicates that each gram of tissue had concentrated an amount of drug contained in some 4.5 ml of external solution. The volume of extracellular space is less than 0.3 ml/g and cannot account for results of this magnitude.

The presence of *d*-tubocurarine in a paralytic dose of 5 μg/ml markedly altered the entry of labeled compound. Pairs of diaphragms were used to test this action. It was found that in every case (16 pairs) the uptake of labeled compound was markedly diminished by the presence of *d*-tubocurarine. This was apparent after 1 hour; after 12 hours, the uptake with curarine was less than half of that found in controls. Certain tissues on which the compound had no obvious pharmacological effect were also studied. In the case of rabbit bladder muscle and rabbit tendon, curarine had no significant effect on the uptake of the labeled compound.

The finding that curarine diminished the entry of labeled iodocholinium into guinea pig diaphragm may be of interest in discussions regarding the mechanism of action of curarine and the well-known antagonism between this drug and the depolarizing agents (*4*). The use of labeled compounds may also provide some direct information regarding the reaction between drugs and their receptor sites in muscle.

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1. This research is supported by U.S. Public Health Service grant No. B-738.
2. We are indebted to H. D. Baldridge, Naval Medical Research Institute, Bethesda, Md., for a specimen of the corresponding dichloro compound from which the labeled derivative was prepared by refluxing it with excess radioactive sodium iodide in acetone for 48 hours in accordance with a suggestion made by Seymour Freis, also of NMRI.
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3 December 1956

Effects of Gibberellic Acid on Growth of Kentucky Bluegrass

Crab grass [*Digitaria sanguinalis* (L.) Scop.] that was nearing the end of its seasonal development at Yonkers, N.Y., was stimulated to renewal of growth by a single application of gibberellic acid. Replicated plots of plants were sprayed until the foliage was moistened with aqueous solutions containing 10 and 100 μg of the acid per milliliter. The plants had been mowed and were about 8 cm tall when they were sprayed on 10 Sept. 1956. By 1 Oct., control plants that had been sprayed with water had assumed the usual autumnal red color and were about 13 cm in height. On the other hand, plants that had been sprayed with gibberellic acid remained green, and those that had been treated with 100 μg/ml had elongated to a height of 26 cm. No weight determinations were made on these plants.

After these observations had been made, an Australian patent application was received (*1*). It deals in part with the effects of gibberellic acid in several plant tests. Data are presented showing that gibberellic acid, applied in the spring as a spray to unspecified pasture plants in the field, produced an increase in dry weight, especially when it was used with fertilizer. Although details are not given, the application also states that gibberellic acid induced the growth of grass under conditions of low light intensity and low temperatures when growth was not expected.

These observations suggested that it would be of value to undertake additional tests with gibberellic acid for inducing the growth of grass, especially during an unfavorable time of the year (*2*). Plots of Kentucky bluegrass (*Poa pratensis* L.) at Greenfield, Ind., were fertilized with a granulated fertilizer (10-10-10) on 23 Oct. 1956, and sprayed once with water (control) or with freshly made solutions of gibberellic acid 3 days later. The plants were in the slow-growth stage common at this time of year.

Within 4 days, the grass that had been treated with gibberellic acid began to grow again as revealed by brightening of the green color and development of new shoots. Plants were harvested by clipping about 4 cm above the ground on 10 Nov.,

15 days after treatment. There had been light frosts with approximate low temperatures of −1, −2, and −4°C. Rainfall was adequate to keep the soil moist during the experiment.

Data on fresh and dry weights of clippings are given in Table 1. Determinations of dry weight were made after clippings had been air-dried for 10 days at 5 to 28°C in a loft and then further dried at 24°C in a vacuum.

It is apparent that, under the conditions of the test, gibberellic acid influenced significantly both the fresh and dry weights of the plants, especially when it was used in conjunction with fertilizer. Treated plants tended to contain more water, as evidenced by the comparison of fresh and dry weights. In this test, and as noted elsewhere (*1*), plants treated with gibberellic acid alone were yellowish-green. When fertilizer was used in conjunction with the gibberellic acid treatment, however, plants were bright green and appeared to offer a juvenile type of foliage that is common in this region in the spring and early summer.

Longer term effects of gibberellic acid, particularly with respect to winter injury, will be observed in the spring and during the subsequent seasons. Observations made since the bluegrass plots were harvested indicate that there may be some deleterious effects. Plants in plots treated with gibberellic acid continued to grow. Irrespective of the fertilization program, by 10 Dec. this new growth tended to be chlorotic and spindly. The ends of many of the leaves were dead, presumably because of the low temperatures that had prevailed. The crown region of the plants did not appear to have been injured, however, because new green tissue was produced on the advent of a short period of warm weather in late December.

Table 1. Fresh and dry weights of clippings from field plots of bluegrass treated with gibberellic acid and fertilizer. Gibberellic acid was applied in water at a rate of about 100 gal/acre. Each entry for fresh and dry weight is based on 3 plots, each 96 ft².

Fertilizer (lb/acre)	Gibberellic acid (g/acre)	Av. fresh wt. (g)	Av. dry wt. (g)
0	0	481	231
0	28	854	345
0	56	740	294
0	112	808	321
215	0	595	246
215	28	999	357
215	56	1117	354
215	112	1208	414
645	0	754	300
645	28	1103	366
645	56	1276	431
645	112	1376	456
L.S.D., 0.01		281	171
L.S.D., 0.05		209	94

These tests suggest that gibberellic acid may be useful for inducing the growth of grass in the fall and in the spring, and perhaps during the winter in warmer regions. When fertilizer is used in conjunction with gibberellic acid, the new growth appears to offer an excellent type of forage.

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2. We are grateful for the statistical assistance of E. V. King and for the aid given by the department of biochemical preparations of Eli Lilly and Company.

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Glucose Oxidase with Iodide-Iodate-Starch or o-Tolidine as a Specific Spray for Glucose

A specific spray test for chromatographically separated glucose has been lacking, because present tests depend on reactions of the carbonyl group, which is common to all reducing sugars, or depend on nonspecific reactions with strong oxidizing agents. We have found that glucose oxidase will catalyze the atmospheric oxidation of a glucose spot on a paper chromatogram to give gluconic acid and hydrogen peroxide (*1*). The formation of traces of gluconic acid on the chromatogram may be shown by a new application of the acid-iodide-iodate-starch reaction, and the peroxidase-catalyzed hydrogen peroxide-*o*-tolidine reaction may be used to demonstrate the formation of hydrogen peroxide.

Glucose oxidase has been used previously for the quantitative and qualitative determination of glucose in solutions (*2*), and its specificity for the oxidation of glucose and its mechanism of action have been established (*3*).

After irrigating a Whatman (*4*) No. 1 paper chromatogram with *n*-butanol, ethanol, and water (10/1/2) and air-drying, we sprayed the glucose area with a glucose oxidase solution prepared by dissolving 10 mg of Takamine Dee-0 in 10 ml of water. After the chromatogram had stood for 15 minutes at room temperature, it was sprayed with a freshly prepared reagent containing 1 percent soluble starch and 5 percent KI in aqueous solution and then with a 5-percent aqueous solution of KIO_3. A final spray, after the color was fully developed, with 5-percent aqueous $NaHCO_3$ delayed air oxidation of the background. With larger amounts of glucose, some of the hydrogen peroxide that is formed reacts with iodide to liberate iodine. However, the sensitivity of this test depends on the instantaneous reaction of gluconic acid at room temperature with the iodide-iodate system to liberate iodine, which in turn yields the familiar intensely blue color with starch (*5*).

As a confirmatory or alternative test for glucose, the hydrogen peroxide formed during the enzymatic oxidation was detected with *o*-tolidine. The air-dried chromatogram was sprayed with a glucose oxidase-peroxidase reagent (*6*) and then immediately with a 1-percent ethanolic solution of *o*-tolidine (*7*). The blue color resulting from the peroxidase-catalyzed reaction of *o*-tolidine with hydrogen peroxide reaches a maximum within a few minutes at room temperature and then gradually fades.

Ten micrograms of glucose that had moved 150 mm on a chromatogram gave a strong color with either of the aforementioned spray tests; 5μg gave a faint color. In order that either of the tests will be valid, it must be established that the color does not appear in the glucose area of the chromatogram in the absence of the glucose oxidase treatment.

The utility of glucose oxidase in detecting the presence of glucose on chromatograms suggests its use in combination with specific hydrolytic enzymes as a reagent for confirming the identity of glucose-containing polysaccharides on chromatograms. This enzyme is also useful as a reagent for removing glucose from solutions prior to chromatography.

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4. Mention of a manufacturer or a commercial product does not imply endorsement by the U.S. Department of Agriculture over others of a similar nature not mentioned.
5. The iodide-iodate-starch system will detect as little as 0.05 μg of gluconic acid per square millimeter under the conditions employed. It is of general usefulness for detecting acid areas on chromatograms and neutral test papers, or

for detecting microgram quantities of acid on the spot plate.

6. One hundred milligrams of Dee-O was dissolved in 10 ml of acetate buffer of *p*H 5.3 to 5.6, and about 1 g of scraped raw potato pulp was added. After it had stood 15 to 20 minutes, the reagent was filtered through glass wool. The raw potato is a convenient, essentially glucose-free source of peroxidase.
7. When *o*-tolidine dihydrochloride was used, 1 g was stirred with 0.45 g of KOH (85 percent pure) in 100 ml of 95-percent ethanol until it was dissolved, and the precipitated KCl was removed by filtration.

12 December 1956

Infrared Spectra of Mixtures of α- and β-D-Glucose Pentaacetate

Infrared spectra have been extensively used to identify sugars and their derivatives (*1*). The α- and β-anomers can also be differentiated through the presence or absence of certain characteristic peaks in their infrared spectra (*2*). In connection with some studies undertaken in this laboratory, it was proposed to use the intensity of an absorption peak characteristic of a particular anomer to determine the concentration of that anomer in solution.

In order to see whether or not this was feasible, we first investigated the infrared spectra of mixtures of the two anomers, α-D-glucose pentaacetate—mp. 112°C; $[\alpha]^{21}D$, +101° (EtOH, *c.*, 0.5) (*3*)—and β-D-glucose pentaacetate—mp, 133–134°C; $[\alpha]^{21}D$, +2° (EtOH, *c.*, 0.5) (*3*, *4*)—in chloroform and acetone solutions. The α- and β-D-glucose pentaacetates were mixed in the proportions 1 α/4 β, 1 α/1 β, and 4 α/1 β at a total concentration of 1.00 percent (wt./vol.), and the infrared spectra were recorded with a Beckman IR3 recording spectrophotometer. This instrument permits one to obtain infrared spectra of compounds in solution without the spectrum including any contributions from the solvent.

Table 1 shows a series of absorption peaks found in the 8- to 15-μ region. The majority of those shown are apparently diagnostic of either the α- or β-anomer. The intensity of absorption is indicated by the figures in parentheses, which represent the percentage absorption, taking the absorption at 5.68 μ as 100 percent. The absorption at 5.68 μ was the same for both the anomers and their mixtures and was one of the most intense bands. There are also shown, for comparison, two peaks that are found in both α- and β-D-glucose pentaacetate. The α-anomer shows a slightly more intense absorption at 8.7 μ than the β-anomer. Both the anomers show essentially the same absorption at 11.15 μ.

Certain absorption peaks, such as that at 8.95 μ which is apparently characteristic of the β-anomer or that at 9.86 μ which is apparently characteristic of the α-anomer, decrease in intensity as the concentration of the anomer is decreased. On the other hand, the absorption peak at 9.65 μ which is characteristic of the β-anomer or the peak at 11.00 μ which is characteristic of the α-anomer rapidly disappears in the presence of the opposite anomer. It should be noted that the intensity of absorption is apparently not a factor. The absorption at 9.65 μ is very intense, while that at 11.00 μ is rather weak. Other examples will be apparent from Table 1. Essentially the same spectra were obtained when the solvent was allowed to evaporate and the solids run as films.

Since certain of the absorption peaks characteristic of an anomer behave as might be expected, and since the optical rotation of the mixtures was as calculated, we do not believe that there has been any interconversion between the α- and β-anomers. A possible explanation is that an association takes place in solution between the α- and β-anomers that suppresses the vibrations responsible for the infrared absorption characteristic of the anomer.

It would seem that considerable care should be taken when infrared analysis is used either for the identification or quantitative determination of sugars, particularly if there is a possibility that anomers are present (*5*).

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Table 1. Infrared absorption at several wavelengths of chloroform or acetone solutions of α- and β- and mixtures of α- and β-D-glucose pentaacetate. Total concentration, 1.00 percent (wt./vol.); wavelength in microns. The figures in parentheses represent the amount of absorption as compared with the absorption at 5.68 μ (percentage). The adsorption at 5.68 μ was the same for each anomer and for the mixtures.

β	4β/1α	1β/1α	1β/4α	α
8.70 (43)	8.65 (43)	8.65 (60)	8.65 (60)	8.65 (65)
8.95 (55)	8.95 (53)	8.95 (46)	8.90 (42)	
9.65 (92)	9.62 (94)			
	9.85 (50)	9.87 (73)	9.87 (73)	9.86 (78)
10.15 (26)	10.15 (26)	10.18 (25)	10.15 (25)	10.15 (24)
			10.35 (16)	10.35 (18)
10.43 (21)	10.45 (18)	10.45 (19)		
10.65 (62)	10.65 (49)	10.65 (53)	10.65 (23)	
10.75 (52)	10.75 (41)	10.75 (44)	10.80 (24)	
			11.00 (35)	11.00 (37)
13.45 (9)	13.45 (7)	13.45 (8)		
	14.05 (6)	14.05 (5)	14.15 (10)	14.17 (13)
14.45 (11)	14.45 (10)	14.42 (9)		

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3 January 1957

Glycolysis by Tumor Mitochondria and the Action of Insulin

The cardinal role of glycolysis (formation of lactic acid from glucose) in the metabolism of living cancer cells has been recognized for well over 30 years (*1*). A high rate of glycolysis may also be readily demonstrated in cell-free homogenates prepared from tumors. However, the view is still widely held, despite evidence to the contrary (*2*), that the glycolytic enzymes of tumor cells (and of normal cells) are localized primarily in the nonparticulate fluid fraction of the cell cytoplasm. Mitochondria are regarded, at best, as potential stimulators of the glycolysis of the fluid fraction or else as playing some obscure part in the integrated functioning of the combined cell fractions. Mitochondria are generally considered not to possess the full complement of enzymes required to convert glucose into lactic acid.

During the course of investigations on hormonal regulation of the subcellular glycolysis of tumors, we have obtained new evidence of high intrinsic rates of anaerobic glycolysis by tumor mitochondria, provided that the mitochondria have been supplemented with supernatant fraction that has been enzymatically inactivated. Thus, when the supernatant fraction of a tumor homogenate

was boiled for 10 minutes, or pasteurized at 60°C for 10 minutes, and added to isolated mitochondria, lactic acid was formed from glucose at notable rates. Mitochondria not so supplemented showed only very low rates of anaerobic glycolysis. The supernatant fraction alone, after heat treatment, likewise produced negligible amounts of lactic acid from glucose as substrate. Illustrative data are given in Table 1.

The tumor mainly used in these experiments was the Cloudman S91 melanoma that was maintained by intramuscular transplantation in C × DBA/2 F_1 hybrid mice. Tumors were chilled rapidly after removal from the animals, and all subsequent operations prior to placing the manometric vessels on the Warburg bath were carried out in the cold. One volume of tissue was homogenized with 2 volumes of 0.25*M* sucrose in a glass tube fitted with a rotating plastic plunger. Homogenates were cleared of nuclei and cell debris by a 1-minute centrifugation with a maximum force of 8000g. The cleared homogenate was then further subjected to a 25- to 30-minute centrifugation at 20,000g. The supernatant fraction (containing microsomes) was thoroughly decanted, and the mitochondrial pellet was resuspended in sucrose solution to approximately one-third of the original volume of the cleared homogenate. Although the mitochondrial pellet was not washed, various lines of evidence indicate that the large activities observed in these experiments were not due to small amounts of adherent supernatant. For example, addition to the mitochondria of small quantities of unheated supernatant produced no such activities; and, as is indicated in a subsequent paragraph, qualitatively different responses to insulin were observed in glycolyzing mitochondria as compared with glycolyzing supernatant fraction.

In the presence of aliquots of either pasteurized or boiled supernatant, mitochondria glycolyzed, at 20°C, at nearly linear rates [$Q_{CO_2}{}^{N_2}(N) = 45–70$] for as long as 3 hours. Linear rates of glycolysis were also observed at temperatures as high as 40°C [$Q_{CO_2}{}^{N_2}(N) = 200–300$], although for shorter periods of time. Results similar to these with the S91 melanoma have also been obtained with mitochondria prepared from centrifuged Erlich ascites cells and Krebs-2 ascites carcinoma cells.

The heat-treated supernatant could be stored for many days at 6°C without loss of activity, but it was rendered inactive by dialysis. The activity of the heat-stable component was duplicated in small part by the following additions to and changes in the medium: adenosine monophosphate, 0.00017*M*; sodium pyruvate, 0.0068*M*; niacinamide, 0.02*M*; K_2HPO_4, 0.0075*M*; and $MgCl_2 \cdot 6H_2O$, 0.0062*M*. On the other hand, addition of a boiled extract of fermenting yeast cells resulted in mitochondrial activities approximating those obtained with boiled tumor supernatant (*2a*).

Experiments in progress indicate that the glycolysis by mitochondria is responsive to both insulin (see Table 2 for illustrative data) and anti-insulin hormones (for example, certain sex-hormone steroids), whereas this has not been found with glycolysis by unheated supernatant fractions prepared from the same tumors. Such a differential response constitutes a profoundly important distinction between the herewith reported mitochondrial glycolysis and the well-known glycolysis of the fluid supernatant fractions.

Recent research has demonstrated that the glycolysis and growth of certain tumors is under the control of a stress-modifiable, insulin-anti-insulin mechanism (*3, 4*), that operates at the hexokinase reaction (*5*). The data reported in this article (*6*) support the view that

Table 1. Anaerobic glycolysis by S91 mouse melanoma mitochondria. Each vessel contained 1.0 ml of a solution of the following components at the final concentrations given: 0.04*M* $KHCO_3$; 0.00098*M* $MgCl_2 \cdot 6H_2O$; 0.00075*M* K_2HPO_4; 0.00015*M* DPN; 0.00018*M* adenosine triphosphate (sodium salt); 0.01*M* glucose; and 0.25*M* sucrose. Mitochondrial suspensions were added in 0.3-ml aliquots (total nitrogen about 1.0 mg), and the fluid volume of each vessel was made to 2.0 ml with either the supernatant fraction treated in the manner indicated or with 0.25*M* sucrose. Lactic acid was determined by the Barker-Summerson method on the vessel contents at the conclusion of the experiment. The gas phase consisted of 95 percent N_2 and 5 percent CO_2 carefully freed of the usual traces of oxygen by passage over hot copper filings with small amounts of hydrogen. The temperature was 20°C. $Q_{CO_2}{}^{N_2}(N)$ = microliters of total acid produced (as indicated by the release of CO_2 from bicarbonate buffer) per milligram of total nitrogen of the mitochondria, per hour. $Q_{LA}{}^{N_2}(N)$ = microliters of lactic acid produced (as determined chemically) per milligram of total nitrogen of the mitochondria, per hour. Initial *p*H was 7.6.

System	$Q_{CO_2}{}^{N_2}(N)$				$Q_{LA}{}^{N_2}(N)$ (3 hr)
	1st hr	2nd hr	3rd hr	3-hr av.	
Mitochondria plus supernatant (60°C, 10 min)	57.1	55.4	53.8	55.4	51.5
Mitochondria plus supernatant (100°C, 10 min)	59.2	48.0	48.1	51.8	47.2
Mitochondria plus yeast extract (100°C, 10 min)	48.0	45.4	45.0	46.1	
Mitochondria	22.2	11.9	6.8	13.6	3.3
Supernatant (60°C, 10 min)	8.5	1.7	1.7	4.0	1.3

Table 2. Effect of insulin on anaerobic glycolysis by mitochondrial and supernatant fractions of S91 mouse melanoma. The system was the same as that described in Table 1 except that each vessel also contained 0.003*M* NH_4Cl. Subcellular fractions were prepared from the same tumors. The supernatant fraction was diluted 1/1 with 0.25*M* sucrose, and 1.0 ml (about 1.5 mg of total nitrogen) was added to each vessel. Low-zinc insulin (*8*) was dissolved in distilled water and added at the rate of 1 unit per vessel. $Q_{CO_2}{}^{N_2}(N)$ values are based on a 30-minute period. The rate of glycolysis by the supernatant fraction, prepared by the given procedure, was relatively constant from experiment to experiment with either glucose or glucose-6-phosphate as substrate. On the other hand, the rate of glycolysis by the mitochondria varied considerably with glucose but not with glucose-6-phosphate as substrate. Variable positive responses to insulin observed in a score of experiments are apparently related to the degree of glycolytic inhibition, at the hexokinase reaction, by endogenous antiinsulin hormones, especially as modified by host stress (*3*).

Experiment No.	$Q_{CO_2}{}^{N_2}(N)$ at 30°C					
	Mitochondria (plus heat-treated supernatant)			Supernatant		
	Minus insulin	Plus insulin	Percentage increase	Minus insulin	Plus insulin	Percentage increase
1	54.9	98.5	79.4	111.3	112.0	0
2	88.4	126.4	42.9	114.3	113.9	0
3	113.8	127.4	12.0	118.1	119.1	0
4	131.2	150.7	14.9	127.2	126.5	0
5	145.6	144.5	0			

mitochondria are the enzymatic sites of intense glycolytic activity and also the view (*3, 7*) that hormonal regulation of glucose phosphorylation in living cells takes place at the mitochondrial level of organization.

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3 January 1957

Analysis of Standard Granite and Standard Diabase for Trace Elements

The standard granite (sample G-1) and the standard diabase (sample W-1) have been used as interlaboratory calibration standards for analysis for major constituents of silicate rocks (*1*). In the course of this study, three sets of spectrochemical analyses of the trace elements were performed by R. L. Mitchell, K. J. Murata, and L. G. Gorfinkle and L. H. Ahrens. Partial trace-element analyses have been subsequently reported by other authors (*2*). The techniques used were neutron activation, stable-isotope dilution, and spectrochemical analysis.

Most of the trace-element data reported for standard granite and standard diabase have been obtained by direct-current-arc spectrochemical procedures. Although these techniques can give results reproducible to better than ± 5 percent, the accuracy is frequently off by as much as a factor of 2, because of large matrix effects, selective volatility of the elements, and so forth. The analyses reported here were performed by x-ray fluorescence techniques. The elements determined were copper, nickel, rubidium, zinc, strontium, zirconium, and manganese. The results are shown in Table 1, where they are recorded as parts per million (ppm).

X-ray fluorescence methods offer the advantages of excellent reproducibility and an exact method of accounting for matrix effects. The analyses were made with a North American Phillips x-ray fluorescence unit, using a tungsten target x-ray tube, a scintillation detector, and a helium atmosphere. Standards consisted of oxides of the elements in an aluminum oxide matrix. Selenium was used as the internal standard for elements below the absorption edge of iron (Zr, Sr, Rb, Zn, Cu, and Ni). The titanium already present in samples G-1 (1500 ppm) and W-1 (6530 ppm) was used as the internal standard for manganese.

The precision of the determinations of elements with concentrations higher than 25 ppm averaged ± 5 percent; the precision for elements with concentrations below 25 ppm averaged ± 10 percent. With the proper selection of an internal standard, the absorption corrections for the matrix should be accurate within a few percent. Therefore, the accuracy of the determinations reported here should lie within the combined errors of sample preparation, precision of counting, and the error of the matrix. The accuracy of the determinations for elements with concentrations greater than 25 ppm should be about ± 10 percent; for those below 25 ppm, about ± 15 percent. However, the accuracy of the Cu determinations is probably not this good because the CuKα radiation is partially interfered with by WLα_1 radiation originating from the x-ray tube, making a background correction difficult.

Since samples G-1 and W-1 are to be used by many laboratories as calibration samples for future analyses, every effort should be made to determine the trace elements in the best possible manner. Most trace-element analyses thus far have been performed by the frequently inaccurate spectrographic technique. This report is an attempt to contribute more accurate information on the trace elements in these important standards.

Table 1. Results of trace-element analysis of the standard granite (sample G-1) and standard diabase (sample W-1).

Element	Concentration (ppm)	
	G-1	W-1
Manganese	212	1400
Nickel	3	68
Copper	18	171
Zinc	26	78
Rubidium	248	25
Strontium	263	197
Zirconium	268	94

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31 December 1956

Gravity Shields

In a recent paper D. C. Peaslee pointed out that so-called "antiparticles"—that is, particles that are related to normal particles by the *charge conjugation* operator of quantum theory—have positive mass and, hence, would be useless for employment in gravity shields (*1*). This argument is, of course, unexceptionable; however, it does not exclude the possibility of elementary particles with negative mass (whose antiparticles would possess negative mass as well), although such particles have not yet been discovered. There are some arguments tending to indicate that such particles may not be capable of existence at all (Pauli's derivation of the connection between spin and statistics), but they are not yet to be regarded as conclusive. In this contribution (*2*), I should like to describe briefly the behavior pattern of such particles if they should exist; I shall also demonstrate that such particles would be of very dubious value in "gravity shields."

For a particle of negative mass, according to Newton's second law ($f = ma$), force and acceleration point in opposite directions. Particles having masses of the same sign will attract each other gravitationally—that is, the *forces* will point toward each other—whereas particles of opposite masses will repel each other. Hence, all *accelerations* of particles of whatever mass will point toward particles of positive mass and away from particles of negative masses. If two particles having masses of opposite sign and equal magnitude act on each other purely gravitationally, then the particle of negative mass will chase the particle of positive mass, both their accelerations pointing in the same direction.

Let us now consider a particle of negative mass which also carries an electric charge. Under the influence of an applied electromagnetic field, such a particle will move according to the value of e/m—that is to say, a particle of negative

mass and positive charge will move just like a particle of positive mass and negative charge. However, it will give rise to an electromagnetic field of its own, which is determined entirely by its charge and velocity and is independent of the sign of its mass; hence two such hypothetical particles can be distinguished by the effects they have on other particles, even though they cannot be separated by a mass spectrograph (which determines only the ratio of charge and mass).

Suppose that particles with negative mass should be discovered one day, and suppose that we should succeed in incorporating them into macroscopic matter. Then such matter would not be polarized gravitationally under the influence of an external gravitational field, and therefore it would not exhibit the kind of shielding properties that a dielectric does with respect to electrostatic forces. Only if the negative-mass particles possess an electric charge is it conceivable that such matter would be polarized gravitationally by means of an applied electric field. Even then, if the negative mass of these hypothetical particles should be of the same order of magnitude as the positive mass of particles now known (protons, neutrons, and the like), the shielding effect will be negligibly small.

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31 December 1956

Primary Quantum Conversion Process in Photosynthesis: Electron Spin Resonance

Some years ago, on the basis of a study of the kinetics of the Hill reaction in flashing light (*1*), together with a variety of independent observations involving both chemical and kinetic studies of photosynthesis as well as the kinetics of some experiments on luminescence (*2*), a proposal was made concerning the nature of the early processes in the transformation of electromagnetic energy into chemical potential. This proposal involved an ordered array of chlorophyll and collateral molecules, suggested by the structural detail, which has been provided for the photosynthetic organelles of green plants.

The sequence of events was to be an absorption leading to the first excited singlet state of chlorophyll, which then was converted into a triplet excitation, followed by an ionization process that would lead to a trapped electron and a hole, these two entities being the reducing and the oxidizing components which must be simultaneously generated. A part of the process involved the extremely rapid neutralization of the hole by capture of an electron from water, or a product formed from it (*3*). The resultant material would then ultimately appear as molecular oxygen. The electron, on the other hand, would pass through a series of carriers (hydrogen carriers) such as are well known in biochemical processes (thioctic acid, pyridine nucleotide, flavin, and so forth) ultimately leading to the reduction of carbon dioxide.

Although the observation of transient changes in the absorption spectrum of these particles during such a process has been pointed out (*4*), it has been difficult to identify the species responsible from such absorption changes in this complex of pigments. In such a sequence, one might expect another physical property, more characteristic of at least two of these species, to be observable—namely, the magnetism of the triplet state of chlorophyll and the magnetism which would be associated with the trapped, unpaired electrons.

Although the direct observation of the total changes in magnetic susceptibility under illumination would be extremely difficult, it seemed likely to us that the sensitivity of the method of electron-spin resonance might provide the means of making such a direct observation, and work was undertaken toward this end at that time (*5*). Early observations on various kinds of leaves and other plant materials gave indications that such an electron spin signal would appear under illumination, and in the middle of last year a report of the existence of such a light-induced signal in chloroplasts appeared (*6*). From the data presented then, as well as our own at that time, it was not possible to decide on the nature of the material responsible for the signal. This material not only could have been the chlorophyll triplet, as proposed, or the trapped electron, but it may also have been radicals of the semiquinone type among the hydrogen carriers on the path between the trapped electron and carbon dioxide.

Table 1. Electron-spin resonance observations on various samples from photosynthetic material. The g value of the resonance was 2.00; at room temperature, the width between points of maximum slope was approximately 10 oersteds; at −140°C, the width between points of maximum slope was approximately 15 oersteds; Light quality: $5800 < \lambda < 8000$ A.

Substance	Light intensity	Temperature (°C)	Signal growth time	Signal decay time
Dried leaves	Low*	25	Minutes	Hours
Dried whole chloroplasts (*8*)	Low*	25	Minutes	Hours
		60	Seconds	Seconds
Wet whole chloroplasts (*9*)	Low*	25	Seconds	Minutes
		−140	Seconds	Hours
Wet small chloroplast fragments (*9*)	Low*	25	Seconds	Hours
Wet large chloroplast fragments (*9*)	Low*	25	~30 sec	~30 sec
Wet large chloroplast fragments	High†	25	~ 6 sec	~30 sec
Wet large chloroplast fragments	High†	−140	~10 sec	Hours

* Low light intensity: approximately 10^{15} quanta/sec into cavity; the number of free electrons at equilibrium was approximately 10^{16}.
† High light intensity: approximately 10^{16} quanta/sec into cavity; the number of free electrons at equilibrium was approximately 10^{16}.

One possible way of eliminating secondary chemical reactions as a potential source of the signal is to reduce the temperature at which the illumination is carried out and determine the effect of this on the rate at which the signal appears. A further variable that seemed important to us in the determination of the growth time of the signal was the rate at which quanta of light are actually impinging upon the sample. This we have also varied. And, finally, the nature of the green sample that is being examined may be expected to determine the growth and decay times of all the various magnetic species we have mentioned. The electron-spin resonance spectra of various samples under a variety of conditions were observed at a frequency of 9.3 kMcy/sec (*7*), and the results are given in Table 1.

It is thus clear that the shortest growth times that we have so far observed are definitely limited by the rate at which quanta arrive at the sample. Second, it is clear that cooling to −140°C— at this temperature we may expect that none of the ordinary enzymatic reactions will proceed at measurable rates—does not significantly lengthen the time required for the full signal to appear, while it does very materially lengthen the time required for the signal to disappear after the light is turned off. These facts are consistent with the idea that the signal

is produced by the product of a physical process only, as distinct from an enzymatic or chemical one, as we normally conceive of it. The observation of a thermal luminescence and semiconductivity for dried chloroplasts has recently been reported and interpreted as consistent with the idea that the chloroplasts have some of the properties of semiconductors (*8*).

The asymmetry of the signal itself (*7*), together with the fact that the decay and probably the growth is not a simple, single logarithmic one even at −140°C, seems to indicate that more than one species is responsible for the over-all signal which we see. Among these species may be the chlorophyll triplet (as mentioned earlier), the trapped electron, and, finally, some species of free radical resulting from the direct dissociation of a chemical bond in the absorption act. While it is possible to suppose that the cooling would enhance the lifetime of the chlorophyll triplet to the extent of hours, it does not seem likely. We are thus left with the trapped electron and the possibilities of a dissociated bond.

It is perhaps worth noting that, whatever the nature of the unpaired electron producing this signal, its coupling with the lattice around it must be rather poor in order that it can produce a signal as narrow as the one we see. This suggests that it is located in a rather delocalized pi-type of orbital. It is to be expected that improvements in technique will lead to a more precise identification of the variety of unpaired electrons which almost certainly result from the illumination of the photochemical apparatus in plants.

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Effect of Psychiatric Disorder on Visual Thresholds

Following a wartime observation that neurotic patients tended to obtain lower scores than normal subjects on tests of "night vision," several experiments (*1*) have been undertaken in which the night vision of normal, neurotic, and psychotic groups has been compared. A fairly consistent finding of this research is that, on the average, psychiatric patients have raised intensity thresholds during the course of dark adaptation (*2*).

The most general effect of psychiatric disorder is, apparently, to elevate the dark-adaptation curve along the log-luminance axis without changing its shape (see Fig. 1). The extent of the displacement varies somewhat from one investigation to another between about 0.1 and 0.5 $\log_{10}$ unit. The effect of psychiatric disorder seems to be equivalent to that of placing a neutral density filter in front of the subject's eyes, thus necessitating a greater amount of light to produce a threshold response.

In this respect, the effect of psychiatric disorder may be compared with that of anoxia, which also tends to shift the dark-adaptation curve along the intensity axis without affecting its shape, by amounts varying between 0.1 and 0.4 $\log_{10}$ unit, depending on the degree of anoxia (*3*). A similar effect has been produced by insulin hypoglycemia (*4*) and by alcohol (*5*). In all three cases, the most plausible explanation of the effect seems to be that these conditions lead to a depression of central nervous activity, either in the retina or at higher levels of the visual system.

It seems possible that some of the effects of psychiatric disorder on visual thresholds may also reflect changes in the nervous system of a similar type. Oxygen deficiency has from time to time been reported to occur in psychotics and to a lesser extent in neurotics (*6*), while Gellhorn *et al.* (*7*) have reported more insulin in psychotic patients than in normal subjects, under stress conditions. More recently Shagass and Naiman (*8*) have provided evidence of a reduced central excitability in hysterics, as determined by their "sedation thresholds" for sodium amytal. Although the evidence on the physiological side is far from satisfactory, it would seem that a hypothesis of lowered central excitability in the visual system merits at least as much consideration as possible alternative explanations of a more psychological nature phrased in perceptual terms (for discussion, see *2*).

The implications of the experimental results and the suggested hypothesis may be considered from several points of view. As far as visual research on dark adaptation is concerned, it should be noted that psychiatric disorder does not in general alter either the *shape* of the dark-adaptation curve or the total *range* of adaptation; hence, it seems unlikely that the actual mechanism of adaptation is affected. The shift of the curve along the intensity axis can be accounted for in terms of a depression of activity in the visual pathways, completely unrelated to the dark-adaptation process itself. The results do not, therefore, conflict with the photochemical theories of dark adaptation proposed by Hecht and others, nor do they provide any evidence for neural mechanisms in dark adaptation. They may, however, like the studies of anoxia, suggest the need for a broader basis for visual theories by forcing photochemical theorists to make explicit and develop factors that are implicit in their equations and regarded as secondary or constant (for example, the efficiency with which the conducting system deals with the products of photochemical reactions).

From the broader viewpoint of psychiatry, abnormal psychology, and neurophysiology, the results are perhaps of greater interest, for they may provide further evidence of the value of visual thresholds as indicators of changes of excitability of the central nervous system. As McFarland (*9*) has pointed out, visual thresholds appear to have certain advantages over other psychophysiological functions as quantitative indices of "physiological imbalance" with regard to sensitivity, to the precision with which the physical measurements involved can be made, and to the fact that the subject is not aware of the changes in the physical intensity of the stimulus that are necessary for him to see it, since at threshold the stimulus always has the same appearance. However, like critical flicker frequency (CFF), now being widely used for this purpose, absolute thresholds taken during dark adaptation are not specifically related to any particular physiological stress or abnormal condition. This would seem to reduce their practical value in psychiatric diagnosis.

From the results so far obtained, there seems no immediate likelihood of distinguishing, on the basis of threshold measurements alone, psychotics from neurotics, hysterics from depressives and psychopaths, or, for that matter, psychiatric patients suffering from functional disorders from patients having various organic diseases. In consequence, considerable caution is necessary when results are interpreted from the psychiatric viewpoint and, as Simonson and Brozek (*10*) point out elsewhere in their review of studies of critical flicker frequency, "As a rule, additional information obtained by independent methods is desirable for more specific correlations."

In spite of this, the possibility should not be overlooked that more detailed ex-

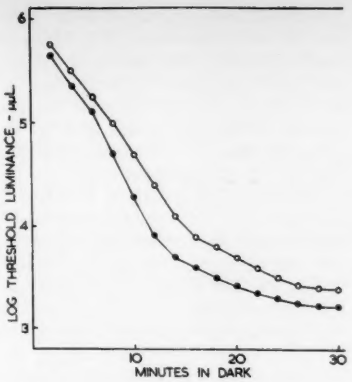

Fig. 1. Mean dark-adaptation curves: ○, psychiatric patients; ●, normal subjects (see 2).

perimental analysis of the responses of different psychiatric categories may reveal at least statistically significant differences between certain diagnostic groups, not only with respect to the position of the dark-adaptation curve on the intensity axis, but also with respect to its shape. Observations in two experiments (*11*) suggest, for instance, that hysterics and anxiety states may differ in the level of their dark-adaptation curves, and one or two hysterics have produced curves that differ in slope from the normal. Such differences suggest that, at least in certain cases, the mechanism of dark adaptation may be impaired, and detailed investigation of these cases may be of considerable interest from the viewpoint of visual research as well as psychiatry. It is possible, for instance, that neural mechanisms operating in dark adaptation may be affected, perhaps via the centrifugal fibers known to exist in the optic nerve. In view of recent work on the "reticular activating system," both in regard to centrifugal control of the sense organs and its role in psychiatric disorder (*12*), such a possibility cannot be dismissed. Worth noting also is the further possibility that differences in dark-adaptation thresholds between anxiety states and hysterics may be paralleled by differences observed between normal subjects classified according to temperamental type (*13*).

With regard to the experimental implications of the general hypothesis suggested in a preceding paragraph, one might expect, on the basis of previous psychophysical research on vision, that changes would occur in the curves that relate a number of visual functions other than absolute thresholds to intensity. Thus, one would expect the curves that relate critical flicker frequency, brightness discrimination, and visual acuity also to be shifted along the intensity axis by psychiatric disorder. The extent of the shift should in each case be similar to the amount of displacement of the dark-adaptation curve, since it is a function of the density of the hypothetical filter that was assumed to have been placed in front of psychiatric patients' eyes. These "deductions" are all susceptible to experimental test.

One final point that requires emphasis concerns the magnitude of the differences so far obtained that can be attributed to the effects of psychiatric disorder. As was pointed out in a preceding paragraph, in certain cases the difference amounts to as much as 0.5 $\log_{10}$ unit, but in other cases it may be as little as 0.1 $\log_{10}$ unit. Although the differences were statistically significant under the experimental conditions in which they were observed, they must be related to the whole body of knowledge concerning the visual mechanism if they are to be seen in proper perspective. Compared with the enormous range of values (1 to 10^6) through which the visual threshold can vary during light and dark adaptation, the changes are very small indeed. Because it seems likely from studies of physiological stresses (*14*) that the observed changes represent the limits of variation that can be expected from disturbances central to the photochemical system, it is clear that refined experimental techniques will be necessary to measure them accurately and to assess their significance in relation to physical and other sources of variation, including individual day-to-day variation, which is often of the order of 0.3 $\log_{10}$ unit (*15*).

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19 December 1956

Histochemical Distribution Pattern of Respiratory Enzymes in the Liver Lobule

Knowledge concerning the function and distribution of enzymes has been gained primarily from procedures involving the structural disintegration of tissue. However, recently developed methods have permitted the localization of specific enzymes in tissue sections. This study deals with the histochemical distribution pattern of four respiratory enzymes—succinic dehydrogenase, cytochrome oxidase, diphosphopyridine nucleotide diaphorase (DPN-diaphorase), and triphosphopyridine nucleotide diaphorase (TPN-diaphorase), respectively—in the liver lobule of higher mammals.

The enzymes concerned are intimately linked to the tricarboxylic acid cycle, which is believed to be the major pathway for the oxidation of many metabolites. Hence, the histochemical study of these enzymes may provide some general information concerning the structural organization of tissue respiration. Furthermore, it may help to elucidate the biochemical anatomy of the liver and its possible significance in the development of localized lesions in liver injury.

The histochemical demonstration of the succinic dehydrogenase system (*1, 2*) and of the DPN- and TPN-diaphorases (*3*) is based on the enzymatic reduction of tetrazolium salts, which serve as indicators of local reductase activity. On reduction, the water-soluble, colorless tetrazolium is converted into a water-insoluble, colored formazan at the site of enzyme activity. The intensity of staining appears to give a rough indication of the amount of enzyme activity present. To achieve specificity of the individual assay, tissue sections are incubated in a medium that allows only the particular enzyme under study to operate on the reduction of the added tetrazolium salt. These methods satisfy most of the criteria that have been adopted for the specificity and reliability of histochemical stains, and they are thoroughly discussed by Farber, Sternberg, and Dunlap (*3*).

The cytochrome oxidase was demonstrated by means of the G-Nadi reaction (*4*), which is based on the oxidative reaction between α-naphthol and dimethyl-*p*-phenylenediamine to form indophenol blue.

In all experiments, frozen sections of freshly obtained pig, horse, and beef liver were incubated in the appropriate media for 30 to 120 minutes at 37.5°C and washed briefly; after formalin fixation, they were mounted in glycerin jelly. The sites of enzyme activity were demonstrated by the more or less intensive deposits of dark blue formazan or indigo blue particles, respectively.

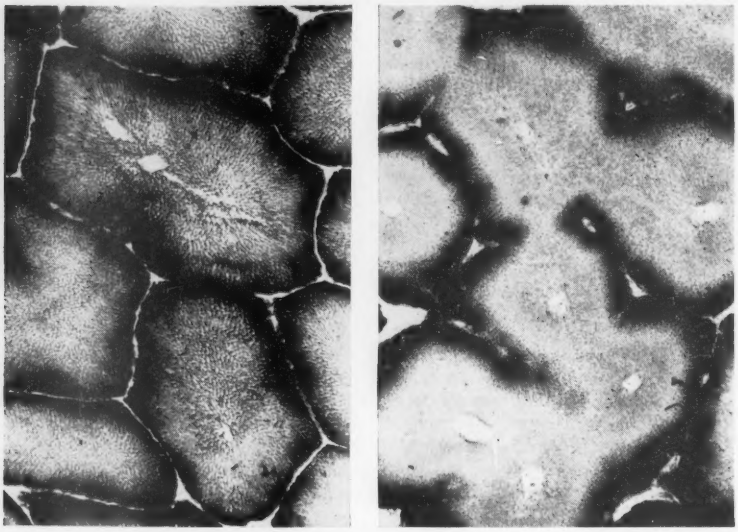

Fig. 1. Distribution of succinic dehydrogenase (dark areas) in the pig (left) and horse (right) liver. Note peripheral concentration of enzyme activity in both species, showing segmental interruptions at the nodal points in the horse. The incubating medium consisted of 5.0 ml of sodium succinate (0.2*M*); 0.1 ml of $CaCl_2$ (0.33*M*); 0.4 ml of $AlCl_3$ (0.01*M*); 0.1 ml of $MgSO_4$ (0.005*M*); 1.0 ml of $NaHCO_3$ (0.6*M*); 5 ml of neotetrazolium (2.0 mg/ml); 0.5 ml of KCN (2-percent); 4.5 ml of phosphate buffer (0.2*M*) at *p*H 7.6; and 3.4 ml of water.

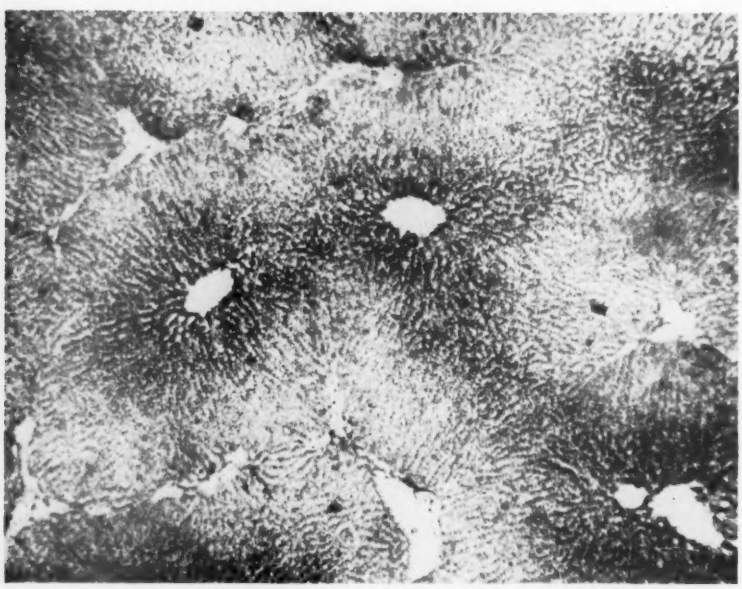

Fig. 2. Distribution of DPN-diaphorase (dark areas) in the horse liver. Note the concentration of enzyme activity around central vein areas, extending segmentally toward the nodal points. The incubating medium consisted of 0.1 ml of alcohol dehydrogenase (1.5 mg/ml); 0.2 ml of ethanol (1.09*M*); 0.3 ml of sodium L-malate (0.5*M*); 0.5 ml of sodium L-glutamate (0.5*M*); 0.2 ml of DPN (5.0 mg/ml); 0.2 ml of semicarbazide (0.1*M* in PO_4 buffer); 0.7 ml of blue tetrazolium (1.0 mg/ml); and 0.8 ml of phosphate buffer (0.1*M*) at *p*H 7.4.

The following results were obtained. (i) The staining for each of the respiratory enzymes showed a highly distinctive and characteristic zonal distribution pattern in the liver lobule. (ii) Succinic dehydrogenase and cytochrome oxidase were particularly concentrated in the periphery of the lobule, their density decreasing rapidly toward the center of the lobule (Fig. 1). (iii) The diaphorases exhibited an almost reverse pattern of localization, showing maximal concentration in the center and more (DPN-diaphorase) or less (TPN-diaphorase) rapidly decreasing density toward the periphery of the lobule (Fig. 2). (iv) Segmental variations of the zonal distribution pattern in different animals are related to the anatomical structure of the liver lobule in these species (Fig. 1).

On the basis of the afore-mentioned assumptions concerning the reliability of histochemical stains, the present results indicate zonal and segmental differences in enzyme activity, which are closely related to the blood flow in the liver lobule. Since the blood enters the lobule at the periphery and escapes through the central vein, there is a corresponding decrease of oxygen tension from the periphery of the lobule to its center. The enzyme distribution obviously reflects this relationship; the concentration gradients of cytochrome oxidase and succinic dehydrogenase directly parallel the slope of oxygen tension, while both the DPN- and TPN-diaphorases exhibit almost reverse concentration gradients. This relationship is particularly striking at the nodal points of the lobule and requires further explication.

The blood is supplied to the lobule from terminal branches of the portal vein and the hepatic artery. Both tributaries join in the formation of a capillary network, which spreads more or less extensively at the periphery of the lobule and finally drains into the sinusoids. In the pig liver, this capillary network entirely surrounds the lobule, thus providing a rather homogeneous blood supply to each segment of the lobule. Hence, the oxygen tension decreases almost concentrically toward the central vein, thus promoting an almost zonal pattern of enzyme distribution (Fig. 1, left).

In the liver of horse, beef, and man, however, the capillary network is more or less confined to the vicinity of the larger tributaries at the edges of the lobule—that is, to the portal areas. Accordingly, the blood supply to the lobule favors the vicinity of the portal areas and

spares an area midway between two portal areas, which is far removed from any rapid and straight running circulation. Mall (*5*) termed these areas *nodal points*. The oxygen tension at the nodal points is almost as low as that around the central vein. Accordingly, the enzyme pattern at these sites corresponds to that of the centrolobular area, thus promoting characteristic segmental deviations of the zonal distribution pattern (Figs. 1, right, and 2).

Since the enzymes under study reflect only part of an integrated metabolic system, it may be assumed that other chemical components reveal similar distribution patterns in the lobule. Recent reports concerning the histochemical demonstration of glucose-6-phosphatase (*6*), adenosine triphosphatase (*7*), and aminooxidase (*8*) are consistent with this assumption.

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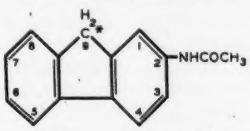
1 November 1956

Orientation of Biochemical Hydroxylation in Aromatic Compounds

Recent reports (*1*) suggest the existence of different mechanisms for the *ortho* and *para* hydroxylation, respectively, of aromatic ring systems. Further evidence on this point can be derived from the following studies. Experiments on the metabolism of *N*-2-fluorenylacetamide in the rat, a species in which this



N-2-fluorenylacetamide.

compound is carcinogenic, have established that hydroxylation occurs at the 1, 3, 5, 7, and 8 positions (*2*). Similar methods have now been used to identify the metabolites of this compound in the guinea pig, a species in which the material failed to induce tumors (*3*).

The data of Table 1, as well as the results of other metabolic experiments (*4*), show that hydroxylation by the guinea pig takes place to a large extent at the 7 position and in an insignificant amount at positions 1, 3, 5, and 8 of the fluorene ring system. This species difference might indicate that hydroxylation at the 1, 3, and 5 positions is carried out by one enzyme system (or perhaps several systems of one type), while hydroxylation at the 7 and 8 positions could be performed by a different mechanism. Apparently the guinea pig possesses, at best, minor amounts of the former, while the rat is endowed with appreciable quantities of both.

The 1 and 3 positions are *ortho* to the substituent in the 2 position and, thus, are subject to the action of an *ortho*-hydroxylase. The 5 position is, of course, remote from the substituent in the 2 position, but it can be considered to be *ortho* to the carbon-carbon bond linking the two phenyl rings of fluorene. Thus, this position might be susceptible to hydroxylation by an enzyme system causing oxidation at the *ortho* carbon atoms. The 7 carbon atom is in an extended *para* relationship to the substituent in the 2 position (*5*). Both the guinea pig and the rat produce a relatively large amount of the 7-hydroxy derivative but only a minor amount of the 8-hydroxy derivative in the metabolism of *N*-2-fluorenylacetamide. Both compounds could conceivably originate from a common intermediate, such as the corresponding dihydrodiol, by a nonselective dehydration favoring the 7-hydroxy derivative. These data are consistent with a hypothesis that a "*para*-hydroxylase" introduces hydroxy groups into aromatic compounds via such intermediates, whereas an *ortho*-hydroxylase may do so by a different mechanism.

These results may have bearing on studies dealing with the mechanism of carcinogenesis, for *ortho*-hydroxylation of certain aromatic amines has been postulated as being involved in the carcinogenic action of these amines (*6*). The production of the *ortho*-hydroxylated derivatives of *N*-2-fluorenylacetamide in the rat (a susceptible species) and the absence of these derivatives in the guinea pig (a resistant species) lends some additional support to that hypothesis.

Table 1. Paper chromatographic identification of metabolites of *N*-2-fluorenylacetamide in rat and guinea-pig urine. Urine was collected from rats and guinea pigs that had been administered *N*-2-fluoren-9-C^{14}-ylacetamide at a dosage of 10 mg/100 g of body weight. Ether extraction of the urines to remove nonconjugated compounds was followed by incubation with β-glucuronidase to hydrolyze the glucuronic acid conjugates. The hydrolyzed mixture was extracted again with ether. This ether extract was chromatographed on S and S paper No. 598 that had been cut in the machine direction in solvent system 3 (*2*), composed of cyclohexane, *t*-butanol, acetic acid, and water (16/4/2/1 parts by volume). The spots were revealed by autoradiography on film. The 8-hydroxy derivative cannot be seen on the chromatogram of rat urine extract because of tailing from the 5-hydroxy derivative (*2*). The pattern of the free, or nonconjugated, compounds was identical with that of the glucuronic acid conjugates (*4*).

Compound	Range of R_f values (× 100) (front to back of spot)	
	Rat	Guinea pig
N-(1-Hydroxy-2-fluorenyl)acetamide	66–88	
N-(3-Hydroxy-2-fluorenyl)acetamide	44–58	
N-(5-Hydroxy-2-fluorenyl)acetamide	18–29	
N-(8-Hydroxy-2-fluorenyl)acetamide	?	17–23
N-(7-Hydroxy-2-fluorenyl)acetamide	8–14	6–17

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6 December 1956

Book Reviews

Steric Effects in Organic Chemistry. Melvin S. Newman, Ed. Wiley, New York; Chapman and Hall, London, 1956. 709 pp. Illus. $12.50.

In accounting for differences in reactivities between organic molecules containing the same functional groups, organic chemists have found it necessary, under the present state of knowledge of molecular structure, to distinguish between the polar, resonance, and steric effects of groups influencing the reacting center. The last of these effects has been brought to a position of relative respectability only in the last decade or so, for within my own experience there was a time when "steric hindrance" tended to be regarded as a poor excuse for an experimental failure.

Here, then, is a collection of the personalized outpourings of some of the more productive and critical contemporary American organic chemists on the subject of steric effects on chemical reactivity, as revealed by kinetic and equilibrium studies. Wisely, as a group, the authors have refused to be restrained, by the title, to a consideration of only steric or bulk effects. In fact, one early detects an insistent note to the effect that reliance upon any one of the separated factors—polar, resonant, or steric—is unlikely to provide an understanding of reactivity, and an impressive proof that consideration of all three is necessary and can be fruitful comprises the last chapter of the work.

Limitations of space preclude evaluation of separate chapters, but the authors, as a group, are to be congratulated for the balance struck between extensive discussions of fine differences in reactivity and recognition of overwhelming modifications of the course of reactions by steric effects.

The order of the chapters is noteworthy. It would seem logical to have placed all those chapters concerned with the establishment of the separate existence of steric factors and efforts to calculate their magnitude earlier in the work, as a general, physical basis for the subsequent discussions of specific reactions. Had this been done, however, the editorially stated purpose of the work—to bring the importance of steric effects to the attention of organic chemists—would not have been so readily achieved. Some of the chapters in question are rather formidable for the less mathematically inclined organic chemist.

The bibliography is extensive and as up to date as possible in such a rapidly changing field. The work presents a comprehensive introduction to organic chemical reactivity and should be read by all serious students of organic chemistry.

RICHARD H. EASTMAN
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Medical Effects of the Atomic Bomb in Japan. Ashley W. Oughterson and Shields Warren, Eds. McGraw-Hill, New York, 1956. 477 pp. Illus. $8.

This long-awaited volume is based on the report of the Joint Commission for the Investigation of the Effects of the Atomic Bomb in Japan, and represents a compilation of the clinical and pathological data collected by that group in Hiroshima and Nagasaki in the period immediately following the detonation of the atomic bombs.

The volume is organized in seven chapters, beginning with a concise four-page summary of the essential factors and findings in the two cities. This is followed by chapters on background of the medical study, use of the weapon, general damage and effects on medical facilities, casualty studies, and clinical, hematologic, and pathologic findings. These are followed by six appendixes, which give the personnel engaged in the collection, analysis, and support of the study; details of material and methods; reports of Japanese scientists consulted; population data; survey and collection techniques; and tabulations of supplementary data on clinical findings.

This volume does not conform, in some respects, to the standards of a textbook. Perhaps it should not be expected to do so. On some occasions the terminology approaches the ambiguous, as in the entire summary statement regarding lymphoid tissue: "Even after 3 days there was atrophy of the lymphoid tissue."

There is some suggestion that this volume presents data related to a past period, as indicated by dependence on such publications as *The Effects of Atomic Weapons,* while still presuming to speak authoritatively on such matters as evacuation policy, and the like. It need only be pointed out that the areas under discussion in Hiroshima and Nagasaki might, under more recent circumstances, be entirely within the fireball. Even within the concepts of this report, certain statements may be somewhat less than conclusive—for example, "evasive action impossible in a period of three seconds."

The chapter on hematology is perhaps the weakest of this report. It is my opinion that the amount of conjecture and theory of development seriously detracts from what should be a factual report of findings. The data deserve more support than the illustrations in this section offer. This is potentially one of the most valuable sections and perhaps the one referred to most frequently. The relative scarcity of good serial hematologic data is rightly stressed, and it is difficult to say to what extent single counts from a probably nonhomogeneous group will represent serial change. I take issue with the tacit acceptance of the significance of cell count data on marrow (cells per cubic millimeter of aspirate). Brief reference is made in this section to recent reports of Lange and of Maloney on later leukemogenic effect.

The chapter on pathology is essentially the report published by Liebow, Warren, and DeCoursey, "Pathology of atomic bomb casualties" [*Am. J. Pathol.* **25**, 853 (1949)], with identical plates. A list of pertinent references to 1952 is included.

Although certain of the foregoing points represent limitations in the basic material, the authors have made a sound and important contribution in making these data available in the present form. There is no comparable set of data in existence. The extent of this report is evidence of the outstanding accomplishment of this group in what was essentially a short field study, made under difficult circumstances.

These data have been in the hands of a limited number of individuals and libraries through an AEC technical report but have been in frequent demand by workers in the radiation field. This should prove to be a useful volume, for reference purposes, for many in the radiobiology field and for those concerned with any aspect of mass casualty and civil-defense medical planning. It is an essential volume for those interested in the problems of irradiation of human beings.

CARL F. TESSMER
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Common Exotic Trees of South Florida (Dicotyledons). Mary F. Barrett. University of Florida Press, Gainesville, 1956. 414 pp. Illus. $8.50.

"The southern half of the Florida Peninsula," writes Mary Barrett, "forms an open-air museum of trees from all the continents. . . ." The aim of her book is to provide a means of identifying the trees and to furnish information about them; in short, to make the museum, as she says, "intelligible."

The 26 pages of keys are based almost entirely on characteristics of leaves and twigs (and are preceded by 24 pages of explanation and illustrations of the terms used)—a truly formidable undertaking and a testimony to the author's courage as well as her ingenuity. For the keys work, at least with a few random herbarium sheets; they would go better with living material. There are, of course, difficulties; the inexperienced will make mistakes and end up in *Annona* instead of *Ficus*; but this is true of all keys, and botanists make mistakes, too.

In the remaining 363 pages, each species has a detailed description, with mention of height, bark, pubescence, shape and dimensions of leaves—all in language which may be described as "moderately technical." This is followed by notes on distribution, names, uses, relatives, and references to literature. Under "distribution" we find specific places in Florida (there is also a section on sight-seeing trips). The numerous illustrations are, for the most part, outlines of leaves. There is a bibliography and a good index. All this is well organized, well written, and well printed, and very helpful to anyone determined to know the trees in question.

I confess, however, that I am not sure who will use the book. It is as "popular" as an accurate treatment of nearly 200 species can be. Will the visitor to Florida take the trouble to master the necessary terms and learn how to use the keys? The very limitation of the subject, which was undoubtedly necessary, is troublesome. One must first know whether or not one's tree is a native of Florida, and whether it is a dicotyledon. However, I hope I am unduly pessimistic about the intellectual energies of the lay reader. At least the book has already proved useful to botanists. The latter will recognize, also, the devoted care that has gone into its preparation (which will probably earn for the author the insult of being called "meticulous"). Of course, one can find minor errors here and there (for instance, the name of the father of botany was Carl Linnaeus); but for scholarship and accuracy, the author deserves great credit indeed.

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Photoconductivity Conference. Held at Atlantic City, 4–6 Nov. 1954. Sponsored by the University of Pennsylvania, Radio Corporation of America, and Office of Naval Research. R. G. Breckenridge, chairman, Editorial Committee. Wiley, New York; Chapman and Hall, London, 1956. 653 pp. Illus. $13.50.

A conference report that comes out more than 2 years after the event raises the question whether it is worth while to read it, since many of the results have been published in detail elsewhere. The answer in this case is *Yes*. Many of the 30 contributions have the character of review papers, which, taken together, cover a wide range of problems in photoconductivity research. This book may be regarded as an excellent introduction to modern photoconductor problems, though not for the uninitiated.

The emphasis is on excitation, absorption, and trapping processes and on the relation of photoconductor properties to band structure and electron lifetimes. These subjects are extensively treated, theoretically as well as experimentally. Minor subjects (also related to lifetime problems) include surface effects, noise, and the photoelectromagnetic effect. There is a large amount of overlapping, but this presentation of different viewpoints, or different kinds of treatment, is not at all to be regretted. It adds, rather, to the interest. Unfortunately, there are discrepancies in the notations; sometimes they do not even agree between figures and corresponding text.

The authors are well known in their fields and give expert and stimulating presentations of problems and results on a consistently high level. This high level does not, however, make the reading difficult, or it does so only sporadically, depending on how well grounded the reader (in any case, the reviewer) may be in the different subjects. All papers are amply referenced. A very valuable addition is the record of the discussion remarks. These sometimes clarify viewpoints or bring out limitations in the treatment.

The papers are arranged in several chapters: "Phenomenological theory of photoconductivity," "Photon absorption processes," "Electron processes," "Photoconducting materials," "Current topics." I am not sure about the use of the word *phenomenological* in the first chapter. A "phenomenological" theory should refer only to phenomena, that is, observed events, as for instance in Rydberg's theory of atomic spectra. What the two papers of this chapter actually give may better be called "model" theories (as Bohr's theory), treating photoconductor properties in terms of a simple model and its significant parameters, such as lifetimes. Since, however, I am myself guilty of loose use of *phenomenological* in the sense of meaning something less than a detailed theory of fundamental mechanisms from first principles, I will not labor this point.

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Evolution and Classification of the Mountain Caddisflies. H. H. Ross. University of Illinois Press, Urbana, 1956. 213 pp. Illus. $6.

The knowledge of the phylogeny and dispersal of members of the aquatic orders of insects and what information is available on the probable place and time of origin are scattered and inadequate. H. H. Ross, who for the last 20 years has been engaged in an exhaustive study of the Trichoptera, has filled a portion of this gap by this treatise on the evolution and distribution of three selected families of caddisflies.

The three families that Ross chose are considered the most primitive: Philopotamidae, Rhyacophilidae, and Glossomatidae. They are adapted to cold (or cool) biotic conditions, are more abundant in the mountainous regions, and are widely distributed in the Holarctic. In North America, the families are represented by about 200 species, with the majority recorded from the western montane region.

The author has shown that a biogeographic correlation exists in these three caddisfly families and that, although the fossil record is very meager, it is possible to construct a phylogenetic tree of the order, of each genus, and often of species groups. The study presents the morphologic characters (largely male genitalia) and dispersal patterns available to show this relationship. Extensive use is also made of the structures of the larvae and pupae and of their net-making or case-making habits. The dispersal pattern, like rate of evolution, varies with each group.

The book is profusely illustrated with 370 figures and 45 charts; all are up to the high standard of other Ross (and University of Illinois Press) publications. The book is exceedingly well indexed, and the bibliography of seven pages is certainly complete.

In the course of the study it was necessary to describe four new genera and 37 new species, primarily from South America and Asia. Some keys to genera and species are included, and in the *Rhyacophila* and a few other genera, considerable synonymy is given.

For the entomologist or zoologist who is interested in phylogeny and dispersal, the work, since it applies to three mon-

tane caddisfly families in a small order of insects (5000 species), should prove of great interest and should stimulate much needed research.

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Chemagro Corporation

Lectures in Immunochemistry. Michael Heidelberger. Academic Press, New York, 1956. 150 pp. $4.

The major portion of this book is devoted to a series of six lectures delivered by the author in Tokyo during the fall of 1955. In this group of readable lectures, Michael Heidelberger has reviewed his contributions and those of his students and collaborators to the field of immunochemistry since his pioneer work with the late O. T. Avery on the isolation of the capsular polysaccharides of the pneumococcus, in the early 1920's. It seems hard to realize that, at the time this work was begun, most immunological reactions were regarded as changes in "colloidal states," and that antibodies were looked upon more as properties of body fluids than as actual substances that could be isolated, weighed, and measured.

It is largely owing to the work of Heidelberger and his students that immunology has become a precise science in which the specific reactions involved can be isolated and studied by the elegant quantitative methods which they developed. In fact, this development has now reached the point where immunochemical methods can be used to guide the chemist in determining the structure and configuration of large and complex molecules such as the polysaccharides.

These lectures constitute a clear and readable course in immunochemistry and can be highly recommended to anyone who wishes to familiarize himself with the development and potentialities of this field. The Tokyo lectures were prepared from a transcription of recordings and, in places, have not been carefully edited. Yet it is perhaps this very fault which helps to give this book the air of informality and simplicity which is its charm.

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New Books

Les Principes de l'Électrophorese. René Audubert and Serge de Mende. Presses Universitaires de France, Paris, 1957. 201 pp. F. 1500.

Man Unlimited. Technology's challenge to human endurance. Heinz Gartmann. Translated by Richard and Clara Winston. Pantheon, New York, 1957. 213 pp. $4.50.

Proceedings of the International Wool Textile Research Conference, Australia, 1955. vol. F, *Histology of Wool and Hair and of the Wool Follicle.* Commonwealth Scientific and Industrial Research Organization, Australia, Melbourne, 1956. 228 pp.

The Effect of Exposure to the Atomic Bombs on Pregnancy Termination in Hiroshima and Nagasaki. Publ. No. 461. J. V. Neel and W. J. Schull. Atomic Bomb Casualty Commission, National Academy of Sciences–National Research Council, Washington, 1956. 241 pp. $2.

Wisconsin's Renewable Resources. James A. Larsen. University of Wisconsin, Madison, 1956. 160 pp.

Statistical Analysis of Stationary Time Series. Ulf Grenander and Murray Rosenblatt. Wiley, New York; Almqvist & Wiksell, Stockholm, 1957. 300 pp. $11.

Water for Industry. A symposium presented on 29 December 1953 at the Boston meeting of the American Association for the Advancement of Science. Publ. No. 45. Jack B. Graham and Meredith F. Burrill, Eds. American Association for the Advancement of Science, Washington 5, 1956. 131 pp. Members, $3.25; nonmembers, $3.75.

Production Forecasting, Planning, and Control. E. H. MacNiece. Wiley, New York; Chapman & Hall, London, ed. 2, 1957. 374 pp. $8.25.

Venoms. Papers presented at the First International Conference on Venoms, 27–30 December 1954, at the annual meeting of the American Association for the Advancement of Science, Berkeley, California. Publ. No. 44. Eleanor E. Buckley and Nandor Porges. American Association for the Advancement of Science, Washington 5, 1956. 467 pp. Members, $8.25; nonmembers, $9.50.

Animal Navigation. How animals find their way about. J. D. Carthy. Scribner's, New York, 1956. 151 pp. $3.95.

Table of the Fresnel Integral to Six Decimal Places. Compiled by T. Pearcey for the Commonwealth Scientific and Industrial Research Organization, Australia. Cambridge University Press, London, 1956 (order from Cambridge University Press, New York). 63 pp. $2.50.

The New World of the Atom. James Stokley. Ives Washburn, New York, 1957. 288 pp. $5.50.

Aeroplanes and Aero-Engines. J. H. Clark, J. Crawley, B. A. J. Hatton, R. J. Way, R. Wood. Philosophical Library, New York, ed. 4, 1956. $6.

Landslides in Clays. Alexandre Collin. Translated by W. R. Schriever. University of Toronto Press, Toronto, Canada, 1956. 160 pp. $6.50.

Semimicro Qualitative Organic Analysis. The systematic identification of organic compounds. Nicholas D. Cheronis and John B. Entrikin. Interscience, New York, ed. 2, 1957. 744 pp. $9.

Notes on Atomic Energy for Medical Officers. An introduction to the subject for service and other medical officers who may be concerned with defense against atomic bombs and similar problems. Royal Naval Medical School. Philosophical Library, New York, 1956. 169 pp. $4.75.

Molecules and Crystals in Inorganic Chemistry. A. E. Van Arkel. Interscience, New York; Butterworths, London, ed. 2, 1956. 270 pp. $4.75.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

W. K. Kellogg Foundation Report for 1955–1956. The Foundation, Battle Creek, Mich., 1957. 253 pp.

Archeology of the Funeral Mound Ocmulgee National Monument, Georgia. Archeological Research Series No. 3. Charles H. Fairbanks, National Park Service, U.S. Department of the Interior, Washington, 1956 (order from Supt. of Documents, GPO, Washington 25). 95 pp. $1.

Technological Advances and Skilled Manpower. Implications for trade and industrial education, an annotated selected bibliography. Misc. 3509. U.S. Office of Education, Washington, rev. ed., 1956 (order from Supt. of Documents, GPO, Washington 25). 67 pp. $0.45.

Directory of Organization and Field Activities of the Department of Agriculture, 1956. Agriculture Handbook No. 76. U.S. Department of Agriculture, Washington, 1956 (order from Supt. of Documents, GPO, Washington 25). 206 pp. $0.55.

Science and the Humanities. Rickman Godlee lecture. Gavin de Beer. Lewis, London, 1956 (for University College, London and University College Hospital Medical School). 21 pp. 2s. 6d.

The Intrinsic Embryonic Development. Verhandelingen der Koninklijke Nederlandse Akademie van Wetenschappen, Afd. Natuurkunde, vol. LI, No. 2. G. Ten Cate. North-Holland, Amsterdam, 1956. 257 pp. Fl. 15.

Vibration Analysis Tables. R. E. D. Bishop and D. C. Johnson. Cambridge University Press, London, 1956 (order from Cambridge University Press, New York). 59 pp. $2.

Keys and Bibliography to the Collembola. Zoology Publs. No. 20. J. T. Salmon. Victoria University College, Wellington, N.Z., 1956 (distributed on exchange basis by the Department of Zoology). 35 pp.

The Development of Polish Science, 1945–1955. Bogdan Suchodolski and Eugeniusz Olszewski. Polonia, Warsaw, 1956. 91 pp.

Genetic Studies with Bacteria. Publ. 612. M. Demerec et al. Carnegie Institution of Washington, Washington, D.C., 1956. 136 pp. Paper, $0.80; cloth, $1.

Diatomaceous Earth in Arizona. A field and laboratory report. John T. Long, Jr., and George G. Olson. Arizona Development Board, Phoenix, 1956. 28 pp.

Armour Research Foundation of Illinois Institute of Technology, Annual Report, 1956. The Foundation, Chicago 16, 1957. 52 pp.

The Indian Association for the Cultivation of Science, Annual Report 1955–1956. The Association, Jadavpur, Calcutta, 32, 1956. 81 pp.

Meetings and Societies

Genetics and Plant Breeding

The half-century just past, during which at least the principal topographic features of the germinal apparatus have been charted, has witnessed major advances in plant breeding also. The parallel is not a coincidence. The genetic discoveries directly stimulated the development of an increasingly comprehensive and incisive technology. Plant breeders perceived that often, if not usually, they could meet the three primary statistical conditions demanded for effective economic exploitation of the hereditary mechanism, the nature of which the geneticists were disclosing—namely, large populations of pedigreed individuals, high selection pressures, and short generation time. Granted these basic advantages, breeders of crop plants were in a fair way to explore the implications, for their art, of all the concepts and techniques that genetics brought forth.

The flow of information has not been entirely one way. The paths which genetics has taken, when not *ad hoc,* have been influenced, in turn, quite as much by the breeder's long and intimate experience in remodeling the few species adapted to domestic use as by the naturalist's knowledge of multiform biological variation in general. But the aggressive young science now has advanced into a region hitherto inaccessible—the generation by artificial means of primary genetic variability—and has also gained measures of control over certain other hereditary phenomena by which the plant breeder's operations can be made even more effective. It is the status of some of these developments that are here under review.

Two hundred eleven plant breeders and geneticists from the United States, Canada, and Latin America and from abroad met 21–23 May 1956, under the auspices of the biology department, Brookhaven National Laboratory, Upton, N.Y., in a Symposium on Genetics in Plant Breeding. Fourteen papers were presented, each of which was followed by an open forum. The formal program was supplemented, at the close, by a "workshop" designed to clarify lines of attack on specific problems.

The plan for the meeting did not envisage dealing inclusively with all the areas in which genetics and plant breeding now interpenetrate, still less with the growing importance of plant breeding as the industrial consumption of plant products rises apace in a world in which the means of adequately feeding increasing millions of people have yet to be instituted. It may be taken for granted that those present were aware that they are custodians of one of the proved and generally applicable means of alleviating widespread economic needs.

Special attention was given on the program to the agronomic significance of mutations artificially induced, particularly by high-energy radiations. It appears from the evidence that x-ray mutations will find a place, possibly an important one, in plant-breeding operations. James MacKey (Svalöf), reviewing the considerable European, and especially Swedish, experience in this field, concluded that the utility of induced mutations now has been established. The x-ray mutation spectrum, even though it consists predominantly of retrogressive changes, has been shown to include occasional variations whereby significant improvement in various agronomic characteristics in several crop species may be effected. MacKey adverted also to the future possibility that artificial mutagens may be the means of generating the novel genetic qualities necessary to extend cultivated plants into regions now marginal for agriculture. Significant in this connection is the recent work of Fahmy and Fahmy, referred to by Steffensen in the discussion of MacKey's paper, on the production by certain alkylating agents of scores of mutant forms in *Drosophila melanogaster* not previously observed in this intensively studied species.

The genetic variations induced by high-energy radiations at a complex locus in oats, conditioning reaction of the plant both to *Helminthosporium victoriae* and *Puccinia coronata,* were described by C. F. Konzak. One mutant resistant to *Helminthosporium* was reported which appeared to retain the reaction to *Puccinia coronata* characteristic of the unaltered locus. Experimental evidence was presented by W. C. Gregory showing that, in the peanut, an important range of agronomically constructive x-ray-induced mutation occurs, including even resistance to *Sclerotium rolfsii,* which is so nonspecific in its pathogenicity that little hope had been entertained previously of controlling genetically the destructive stem rot which this soil-borne fungus incites.

E. R. Sears presented a masterly cytogenetic analysis of the processes involved in transferring selectively a factor for leaf-rust resistance from *Aegilops umbellulata* to a 21-chromosome wheat. The difficulties entailed by a proximal location on the *Aegilops* chromosome of the resistance factor, and linkage with deleterious genes, were surmounted by using x-irradiation to transpose the desired short segment to a wheat chromosome. The case provides an elegant example of the refinement attainable when well-conceived cytogenetic techniques are brought to bear on a clearly defined, but refractory, breeding problem.

A new approach to the problem of identifying the particular reactions between host and parasite controlling disease development, utilizing artificially induced mutations in the parasite, was illustrated by G. W. Keitt and D. M. Boone in an account of their notable work on the apple scab fungus.

As a counterpoise, so to speak, to a viewpoint in which artificially induced mutations might tend to be currently overemphasized in plant-breeding methodology, J. R. Harlan discussed the rich resource represented by existing global collections of crop species and their wild relatives and stressed the importance of capturing the remainder of this variability before extinction occurs as a result of varietal displacement. The potentialities of such material have been quite inadequately explored. Harlan cited the results of an experiment initiated by H. V. Harlan, and carried forward later by others, in which a panmictic population of barleys was created by the systematic hybridization of several strains, highly diverse in geographic origin and economic desirability. The stock then was propagated in bulk for some 30 generations without conscious selection. Samples drawn at intervals from F_8 onward showed that the pool had become a veritable Pandora's box of both the genetically good and evil, and that types had evolved in it exceeding, in agronomic performance, the best strains independently developed by conventional methods in the same region from seemingly more promising foundation lines.

A comprehensive account was given by D. F. Jones of the system in maize whereby male fertility and sterility are conditioned by nuclear genes interacting with cytoplasmic factors transmitted through the egg only. Employment of this mechanism promises to facilitate

significantly the controlled mass hybridization of selected parent lines now generally employed in producing commercial seed corn. W. H. Gabelman reviewed the progress which has been made in utilizing the same phenomenon in the systematic production of hybrid seed in certain vegetable species since 1943, when H. A. Jones and A. E. Clarke described it in the onion and directed attention to its economic possibilities.

A noteworthy contribution to the symposium was G. Ledyard Stebbins' appraisal of polyploidy in plant breeding from the point of view of one intimately acquainted with the phenomenon both in nature and as an object of experimental manipulation. This report was an impressive example of the abiding value of knowledge patiently acquired by critical research in a fruitful field which became partially discredited by the extravagant and unfulfilled hopes of immediate benefits aroused, in the United States at least, following the discovery, about 20 years ago, of colchicine as an agent for doubling the chromosome number.

One of the remarkable achievements in genetics has been elucidation of the incompatibility mechanisms operating in numerous species of flowering plants, including several of economic importance. D. Lewis, a leading contributor in this field, discussed these mechanisms, with particular reference to the restrictions imposed on breeding systems. A puzzling fact encountered by Lewis, seemingly important for mutation theory, is that indubitable genetic changes of one active incompatibility allele to another were not encountered in his cultures, either as spontaneous events or after irradiation, even when sought for on an enormous scale. The mutations regularly observed were to self-compatibility.

Maize breeders in the United States have been preoccupied for some 40 years in exploiting the unique breeding procedure formulated initially by G. H. Shull and rendered commercially practicable by the double hybrid method of combining four inbred lines contrived by D. F. Jones. The genetic wellsprings from which this spectacularly successful development arose are still flowing, even though there have been no more geyser-like eruptions like that which Shull channeled toward the economic stream. One of the tools which recent maize genetics research has made available is a wide array of chromosomes structurally rearranged in known ways. E. G. Anderson pointed out, in a review of the technologic possibilities of this material, that such marked chromosomes are well suited as vehicles for the selective introduction, into highly improved lines, of especially desirable traits from exotic sources.

Genetic improvement of crop plants depends, in many cases, on efficiency of selection for quantitatively varying characters controlled by numerous genes whose effects are not individually recognizable. C. C. Cockerham discussed possible ways of separating the genotypic variance in cases of this kind into genic, dominance, and epistatic components, the relative magnitudes of which, in a given case, would suggest the most appropriate breeding plan. The diallel system of mating was reviewed in a similar relation by H. A. Allard.

Edgar Anderson pointed out, in a lively and challenging address, parallels between the problems of the taxonomist and the plant breeder in handling multiform variability. The ingenious methods he has devised for graphically summarizing multiple-sense-impression data were illustrated. Emphasis also was given the wide significance of introgressive hybridization in determining the genetic structure of plant populations.

The papers presented at the symposium and the discussions which followed them are being published under the auspices of the biology division, Brookhaven National Laboratory, in a paper-bound volume of about 250 pages, printed by offset. Copies will be available from the Office of Technical Services, Department of Commerce, Washington 25, D.C., after 1 Feb. 1957.

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Southeastern Biologists

The 18th annual meeting of the Association of Southeastern Biologists will be held at the University of Georgia, Athens, 18–20 Apr. The time and place are significant, since the association was founded just 20 years ago at this same university. This is the first meeting of the organization at its birthplace since its founding.

Meeting with the association are the Southeastern Section of the Botanical Society of America and the Southern Appalachian Botanical Club. The program includes a symposium on the evening of 18 Apr., followed by a smoker; papers will be given on 19 Apr., followed by the annual address of President George C. Kent of Louisiana State University and the presentation of awards. Field-trips are planned for the 20th.

Zoonoses

"Animal disease and human health" will be the subject of a joint conference sponsored by the New York Academy of Sciences and the U.S. Public Health Service Communicable Disease Center at the Barbizon-Plaza Hotel, New York, 2–4 May. The conference will provide a 10-year progress report on the zoonoses, diseases of lower animals which are transmissible to man, or diseases caused by animal parasites. Diseases such as psittacosis, brucellosis, cat scratch fever, rabies, anthrax, and encephalitis will be reviewed.

Other diseases will be discussed from the standpoint of possible relationship to similar conditions in man. An example is pulmonary adenomatosis, which has been decimating sheep flocks in many parts of the world and has several factors in common with lung cancer in human beings. Inquiries concerning the conference should be addressed to Mrs. Eunice Thomas Miner, Executive Director, New York Academy of Sciences, 2 E. 63 St., New York 21, N.Y.

Women Engineers

The Society of Women Engineers, which has nearly 700 members, estimates that approximately 200 women engineers will attend the annual meeting that will take place at the Shamrock-Hilton Hotel, Houston, Tex., 15–17 Mar. Since a number of delegates to the 1956 convention expressed a desire to learn more about the oil industry, the theme chosen for this convention is "Oil." A field trip is planned for 15 Mar. under the sponsorship of the Gulf Oil Company.

The agenda for 16 Mar. includes a progression of technical talks describing the various phases of the oil industry. The speaker for the annual banquet will be Lillian M. Gilbreth, outstanding in the field of time and motion study, holder of at least ten degrees, and author of many well-known books. For further information, communicate with Elizabeth M. Scholtzhauer, 7927 Glenscot St., Houston 17, Tex.

Forthcoming Events

April

15–17. Systems for Information Retrieval, symp., Cleveland, Ohio. (J. H. Shera, School of Library Science, Western Reserve Univ., Cleveland 6.)

15–18. American Personnel and Guidance Assoc. and constituent divisions: American College Personnel Assoc., American School Counselor Assoc., National Assoc. of Guidance Supervisors and Counselor Trainers, National Vocational Guidance Assoc., Student Personnel Assoc. for Teacher Education: Detroit, Mich. (A. A. Hitchcock, APGA, 1534 O St., NW, Washington 5.)

15–18. Host-Specificity and Parallel Evolution among Parasitic Insects and Worms, symp., Neuchatel, Switzerland. (J. G. Baer, C.P. 2, Neuchatel 7.)

15–18. International Inst. of Differing Civilizations, 30th session, Lisbon, Portu-

WILEY — BOOKS

EXPERIMENTAL DESIGNS, 2nd Ed.

By William G. Cochran, The Johns Hopkins University, and Gertrude M. Cox, University of North Carolina. Now revised and expanded to take into account recent developments in the field. Presents plans of all the useful types of experimental designs and shows the kind of work for which each design is appropriate with illustrations of its practical use.

New chapters include information on the fractional replication of factorial experiments, and on methods and new designs for experiments in which the factors represent quantitative variables measured on a continuous scale. One of the Wiley Publications in Statistics, Walter A. Shewhart and S. S. Wilks, Editors. 1957. Approx. 464 pages. Prob. $7.50.

ORGANIC REACTIONS, Volume 9

Editor-in-Chief: Roger Adams, University of Illinois. This new addition to the well-known series provides additional compilations of important synthetic chemical reactions. As in the previous volumes, the survey of each reaction includes a general discussion of method, modifications, examples of applicability, special precautions, a detailed description of procedure, expected yields, and other pertinent data. 1957. Approx. 484 pages. Prob. $12.50.

PHYSICAL SCIENCE FOR LIBERAL ARTS STUDENTS

By Hugo N. Swenson and J. Edmund Woods, both of Queens College. Describes the special methods and procedures that have been found useful and effective in the natural sciences. The text aims at answering the question: "What is science and how do the natural sciences differ from other intellectual fields?" The authors analyze the roles played by experiment, hypotheses, theories, and models. With emphasis on a historical perspective, the book outlines experimental methods of science through an examination of astronomy, chemistry, and physics. 1957. Approx. 310 pages. Prob. $6.50.

SCIENTIFIC FRENCH

By William N. Locke, The Massachusetts Institute of Technology. Offers a quick, practical approach to the reading of contemporary technical French. No previous knowledge of the language is required. Selections and sample sentences are taken from current scientific books and journals. Excluding features of grammar restricted to the literary, poetic, or spoken language, the author thoroughly covers the constructions that students will encounter in reading technical French. The book is based on material used by the author for six years at M.I.T. and published in a preliminary edition by The Technology Press. 1957. 112 pages. Prob. $2.25.

SCIENTIFIC GERMAN

By George E. Condoyannis, St. Peter's College. Designed for the student who wishes to acquire a rapid and direct reading knowledge of German adequate to cope with the technical articles and books in the field. It is planned for use with unsimplified scientific reading matter in conjunction with a dictionary, and represents a rigorous and single-minded pursuit of the reading aim exclusively. The author handles the material from the point of view of recognition of forms instead of their reproduction. 1957. Approx. 180 pages. Prob. $2.50.

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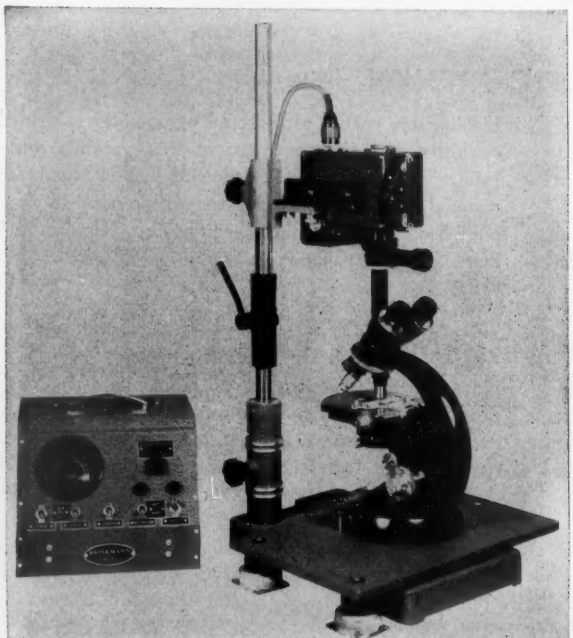

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15–19. American Assoc. of Immunologists, annual, Chicago, Ill. (F. S. Cheever, Graduate School of Public Health, Univ. of Pittsburgh, Pittsburgh 13, Pa.)

15–19. American Soc. for Experimental Pathology, annual, Chicago, Ill. (C. C. Erickson, Inst. of Pathology, Univ. of Tennessee, 858 Madison Ave., Memphis.)

15–19. American Soc. for Pharmacology and Experimental Therapeutics, Chicago, Ill. (H. Hodge, Dept. of Pharmacology, Univ. of Rochester, Rochester, N.Y.)

15–19. Federation of American Societies for Experimental Biology, annual, Chicago, Ill. (M. O. Lee, FASEB, 9650 Wisconsin Ave., Washington 14.)

15–19. High Energy Nuclear Physics Conf., 7th annual, Rochester, N.Y. (R., Marshak, Univ. of Rochester, Rochester.)

15–20. American Inst. of Nutrition, annual, Chicago, Ill. (R. W. Engel, Dept. of Biochemistry and Nutrition, Virginia Polytechnic Inst., Blacksburg 13, Va.)

16–18. Nuclear Tests for Nondestructive Testing Applications, symp., Chicago, Ill. (American Soc. for Testing Materials, 1916 Race St., Philadelphia 3, Pa.)

17–19. American Assoc. of Anatomists, annual, Baltimore, Md. (L. B. Flexner, School of Medicine, Univ. of Pennsylvania, Philadelphia 4.)

18–20. Assoc. of Southeastern Biologists, annual, Athens, Ga. (J. C. Dickinson, Jr., Univ. of Florida, Gainesville.)

18–20. Ohio Acad. of Science, annual, Bowling Green. (R. W. Dexter, Dept. of Biology, Kent State Univ., Kent, Ohio.)

18–20. Southern Soc. for Philosophy and Psychology, annual, Gatlinburg, Tenn. (W. B. Webb, U.S. Navy School of Aviation Medicine, Pensacola, Fla.)

18–20. Venereal Disease Postgrad. Conf., 26th, Memphis, Tenn. (H. Packer, Dept. of Preventive Medicine, Univ. of Tennessee College of Medicine, Memphis 3.)

18–21. American Soc. of Ichthyologists and Herpetologists, 37th annual, New Orleans, La. (F. R. Cagle, Dept. of Zoology, Tulane Univ., New Orleans 18.)

19–20. Arkansas Acad. of Science, annual, Fayetteville. (L. F. Bailey, University of Arkansas, Fayetteville.)

19–20. Seismological Soc. of America, annual, Los Angeles, Calif. (P. Byerly, Bacon Hall, Univ. of California, Berkeley 4.)

20–26. Industrial Health Conf., 12th natl., St. Louis, Mo. (E. C. Holmblad, Industrial Medical Assoc., 28 E. Jackson Blvd., Chicago 4, Ill.)

22–24. National Acad. of Sciences, annual, Washington, D.C. (H. L. Dryden, NAS, 2101 Constitution Ave., NW, Washington 25.)

23–25. Chemistry and Biology of Mucopolysaccharides, Ciba Foundation Symp. (by invitation only), London, England. (G. E. W. Wolstenholme, 41 Portland Pl., London, W.1.)

23–25. Solid State Devices in Electric Circuits, symp., New York, N.Y. (J. Griesmann, Microwave Research Inst., 55 Johnson St., Brooklyn 1, N.Y.)

23–26. American Industrial Hygiene Assoc., annual, St. Louis, Mo. (G. D. Clayton, AIHA, 14125 Prevost, Detroit 27, Mich.)

23–27. Separation of Isotopes, colloquium of IUPAP, Amsterdam, Netherlands. (J. Kistemaker, Laboratorium voor Massaspectrografie, Hoogfe Kadijk 202, Amsterdam C.)

24–25. Industrial Research Conf., Chicago, Ill. (C. E. Barthel, Armour Research Foundation, Illinois Inst. of Technology, 10 W. 35 St., Chicago 16.)

24–25. Recent Advances in the Study of Venereal Disease, 8th annual symp., Washington, D.C. (W. J. Brown, Program Committee Chairman, Communicable Disease Center, Atlanta, Ga.)

24–26. Purity Control by Thermal Analysis, IUPAC, Amsterdam, Netherlands. (W. M. Smit, Central Inst. for Physico-Chemical Constants, Biltstraat 172, Utrecht, Netherlands.)

24–26. Sanitary Engineering Conf. on Solids Handling and Anaerobic Digestion, New York, N.Y. (W. W. Eckenfelder, Jr., Civil Engineering Dept., Manhattan College, New York 71.)

24–27. Plant Quality, 2nd internatl. colloquium, Paris, France. (L. Genevois, Faculté des Sciences, Université de Bordeaux, 20, Cours Pasteur, Bordeaux, France.)

25–26. Institute of Environmental Engineers, 1st annual tech. conf., Chicago, Ill. (G. D. Wilkinson, IEE, 9 Spring St., Princeton, N.J.)

25–26. Midwest Benthological Soc., annual, Urbana, Ill. (A. Lopinot, 205 W. Osie, Gillespie, Ill.)

25–27. American Physical Soc., Washington, D.C. (K. K. Darrow, APS, Columbia Univ., New York 27.)

25–29. Pan American Cancer Cytology Cong., Miami, Fla. (J. E. Ayre, New York Univ., New York, N.Y.)

26–27. Alabama Acad. of Science, annual, Jacksonville. (H. A. McCullough, Dept. of Biology, Howard College, Birmingham, Ala.)

26–27. American Assoc. of University Professors, annual, New York, N.Y. (R. F. Fuchs, AAUP, 1785 Massachusetts Ave., NW, Washington 6.)

26–27. Iowa Acad. of Science, annual, Cedar Falls. (J. L. Laffoon, Dept. of Zoology and Entomology, Iowa State College, Ames.)

26–27. Kentucky Acad. of Science, Mammoth Cave. (G. Levey, Berea College, Berea, Ky.)

26–27. Mississippi Acad. of Sciences, annual, Columbus. (C. Q. Sheely, State College, Miss.)

26–27. Montana Academy of Sciences, 17th annual, Billings. (L. H. Harvey, Montana State Univ., Missoula.)

26–27. South Dakota Acad. of Science, annual, Sioux Falls, S.D. (J. M. Winter, Botany Dept., Univ. of South Dakota, Vermillion.)

26–27. West Virginia Acad. of Science,

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annual, Keyser. (M. Ward, Glenville State College, Glenville, W. Va.)

26–28. Cooper Ornithological Soc., annual, Los Angeles, Calif. (J. Davis, Hastings Reservation, Jamesburg Route, Carmel Valley, Calif.)

27–2. Scientific Apparatus Makers Assoc., 39th annual, White Sulphur Springs, W. Va. (SAMA, 20 N. Wacker Dr., Chicago 6, Ill.)

28. American Soc. of Hospital Pharmacists, New York, N.Y. (Mrs. G. N. Francke, 1812 Norway Rd., Ann Arbor, Mich.)

28–30. American Assoc. of Colleges of Pharmacy, annual, New York, N.Y. (G. L. Webster, Univ. of Illinois College of Pharmacy, 808 S. Wood St., Chicago 12.)

28–2. Southwestern and Rocky Mountain Division–AAAS, annual, Tucson, Ariz. (F. E. E. Germann, 1800 Sunset Blvd., Boulder, Colo.)

28–3. American Pharmaceutical Assoc., annual, New York, N.Y. (R. P. Fischelis, APA, 2215 Constitution Ave., NW, Washington 7.)

28–3. Soc. of American Bacteriologists, annual, Detroit, Mich. (J. H. Bailey, Sterling-Winthrop Research Inst., Rensselaer, N.Y.)

29–30. National Assoc. of Boards of Pharmacy, annual, New York, N.Y. (P. H. Costello, NABP, 77 W. Washington St., Chicago 2, Ill.)

29–1. American Assoc. of Spectrographers, 8th annual, Chicago, Ill. (T. H. Zink, H. Cohn & Sons, 4528 W. Division St., Chicago 51.)

29–1. American Geophysical Union, 38th annual, Washington, D.C. (W. E. Smith, AGU, 1515 Massachusetts Ave., NW, Washington 5.)

29–1. American Oil Chemists' Soc., 48th annual, New Orleans, La. (R. T. O'Connor, Southern Regional Research Laboratory, New Orleans.)

29–2. Flight Test Instrumentation Symp., 3rd annual, Los Angeles, Calif. (E. Spencer, Los Angeles Section, Instrument Soc. of America, 5225 Wilshire Blvd., Los Angeles 36.)

29–2. International Acad. of Proctology, 9th annual, New York, N.Y. (A. J. Cantor, IAP, 147–41 Sanford Ave., Flushing 55, L.I.)

29–4. Irrigation and Drainage, 3rd internatl. cong., San Francisco, Calif. (W. E. Blomgren, 260 Leetsdale Dr., Denver 22, Colo.)

30–1. Metal Powder Assoc., 13th annual, Chicago, Ill. (MPA, 130 W. 42 St., New York 36.)

May

1–2. Image Formation and Measurement with Electronic Techniques, symp., Boston, Mass. (F. Brech, 26 Farwell St., Newtonville, Mass.)

1–3. Electronic Components Conf., Chicago, Ill. (R. M. Soria, 1830 S. 54 Ave., Chicago 50.)

1–3. Society for Experimental Stress Analysis, spring, Boston, Mass. (W. M. Murray, SESA, P.O. Box 168, Cambridge 39, Mass.)

2–4. American Philosophical Assoc., annual, Chicago, Ill. (W. H. Hay, Bascom Hall, Univ. of Wisconsin, Madison 6.)

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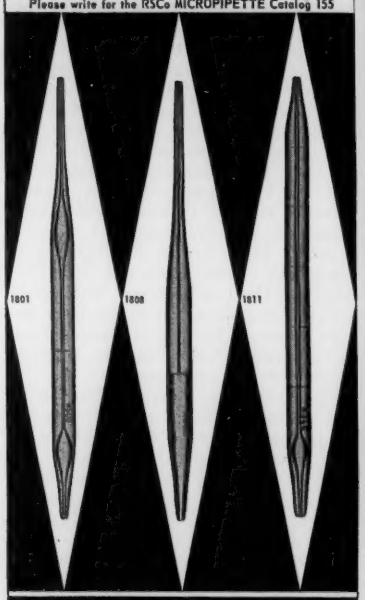

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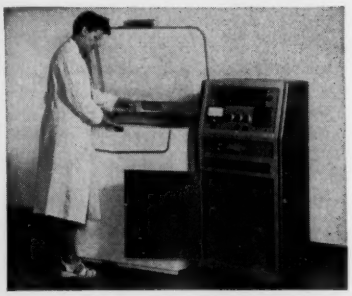

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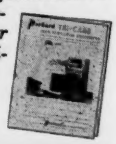

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2–4. Animal Disease and Human Health Conf., New York, N.Y. (Mrs. E. T. Miner, New York Acad. of Sciences, 2 E. 63 St., New York 21.)

2–4. Illinois State Acad. of Science, annual, Normal. (R. A. Evers, Illinois Natural History Survey, Urbana.)

2–4. Kansas Acad. of Science, annual, Manhattan. (C. T. Rogerson, Dept. of Botany, Kansas State College, Manhattan.)

2–4. Midwestern Psychological Assoc., annual, Chicago, Ill. (D. W. Fiske, Dept. of Psychology, Univ. of Chicago, Chicago 37.)

2–5. Society for American Archaeology, annual, Madison, Wisc. (D. A. Baerreis, Dept. of Sociology and Anthropology, Univ. of Wisconsin, Madison 6.)

3. Engineers and Architects Conf., 4th annual, Columbus, Ohio. (G. B. Carson, College of Engineering, Ohio State Univ., Columbus 10.)

3–4. Minnesota Acad. of Science, Rochester. (B. O. Krogstad, Univ. of Minnesota, Duluth 5B.)

3–4. North Carolina Acad. of Science, annual, Winston-Salem. (J. A. Yarbrough, Meredith College, Raleigh, N.C.)

3–4. North Dakota Acad. of Science, annual, Grand Forks. (B. G. Gustafson, Chemistry Dept., Univ. of North Dakota, Grand Forks.)

3–9. Food Additives, 3rd symposium, Como, Italy. (International Bureau of Analytical Chemistry of Human and Animal Food, 18, avenue de Villars, Paris 73, France.)

4–5. American Psychosomatic Soc., 14th annual, Atlantic City, N.J. (I. A. Mirsky, APS, 551 Madison Ave., New York 22.)

4–5. Population Assoc. of America, annual, Philadelphia, Pa. (D. O. Price, Inst. for Research in Social Science, Univ. of North Carolina, Chapel Hill.)

5–9. American Ceramic Soc., 59th annual, Dallas, Tex. (C. S. Pearce, ACS, 4055 N. High St., Columbus 14, Ohio.)

5–10. International Cong. of Otolaryngology, 6th, Washington, D.C. (P. H. Holinger, 700 N. Michigan Ave., Chicago 11, Ill.)

7. International Hydrographic Conf., 7th, Monte Carlo, Monaco. (International Hydrographic Bureau, Quai des Etats-Unis, Monte Carlo.)

7–24. World Health Assembly, 10th Geneva, Switzerland. (World Health Organization, Palais des Nations, Geneva.)

8–9. European Federation of Chemical Engineering, 12th, Amsterdam, Netherlands. (Federation, Frankfurt/Main, 7, Germany.)

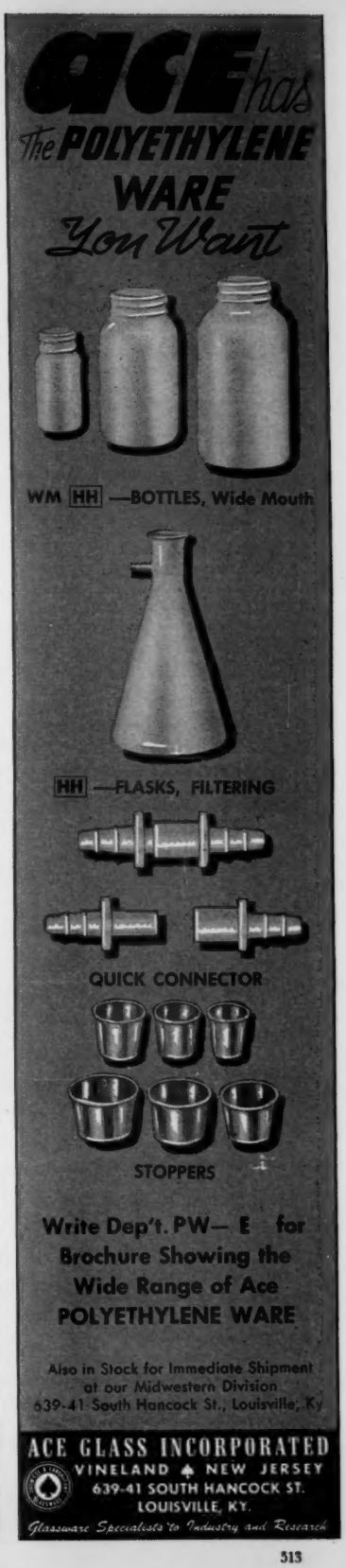
8–11. American Astronomical Soc., Cambridge, Mass. (J. A. Hynek, Smithsonian Astrophysical Observatory, 60 Garden St., Cambridge 38.)

8–11. American Helicopter Soc., 13th annual, Washington, D.C. (H. M. Lounsbury, AHS, 2 E. 64 St., New York 21.)

9. Dietary Essential Fatty Acids, Assoc. of Vitamin Chemists, Chicago, Ill. (M. Freed, Dawe's Laboratories, Inc., 4800 S. Richmond St., Chicago 32.)

9–10. Microwave Ferrites and Related Devices and Their Applications, New York, N.Y. (S. Weisbaum, Bell Telephone Laboratories, Murray Hill, N.J.)

9–10. Operations Research Soc. of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America, 5th annual, Philadelphia, Pa. (M. L. Ernst, P.O. Box 2176, Potomac Sta., Alexandria, Va.)

9–11. Virginia Acad. of Science, Old Point Comfort. (F. F. Smith, Box 1420, Richmond, Va.)

9–12. American Psychoanalytic Assoc., Chicago, Ill. (J. N. McVeigh, APA, 36 W. 44 St., New York 36.)

10–11. Indiana Acad. of Science, Turkey Run State Park, Ind. (H. Crull, Dept. of Mathematics, Butler Univ., Indianapolis 7.)

12–13. International Soc. of Bronchoesophagology, cong., Philadelphia, Pa. (C. L. Jackson, 1901 Walnut St., Philadelphia 3.)

12–16. Electrochemical Soc., Washington, D.C. (H. B. Linford, 216 W. 102 St., New York 25.)

12–16. Institute of Food Technologists, annual, Pittsburgh, Pa. (C. S. Lawrence, IFT, 176 W. Adams St., Chicago 3, Ill.)

13–15. Radiation Research Soc., annual, Rochester, N.Y. (A. Adelmann, Nuclear Science and Engineering Corp., P.O. Box 10901, Pittsburgh 36, Pa.)

13–15. Recent Developments in Research Methods and Instrumentation, symp., Bethesda, Md. (J. A. Shannon, National Institutes of Health, Bethesda.)

13–15. Structure of Electrolytic Solutions, NSF symp., Washington, D.C. (H. B. Linford, Electrochemical Soc., 216 W. 102 St., New York 25.)

13–16. Semiconductor Symposium, 5th annual, Washington, D.C. (H. M. Pollack, Semiconductor Div., RCA, 415 S. 5 St., Harrison, N.J.)

13–17. American Psychiatric Assoc. annual, Chicago, Ill. (D. Blain, APA, 1785 Massachusetts Ave., NW, Washington 6.)

14–16. International Soc. of Audiology, cong., St. Louis, Mo. (S. R. Silverman, 818 S. Kingshighway, St. Louis 10.)

15–16. Space Age Symposium, Southern Research Inst., Birmingham, Ala. (R. D. Osgood, Jr., Southern Research Inst., 917 S. 20 St., Birmingham 5.)

16–18. Engineering Industries Exposition, New York, N.Y. (H. Becher, New York State Soc. of Professional Engineers, 1941 Grand Central Terminal Bldg., New York 17.)

17. Maryland Acad. of Sciences, annual, Baltimore, Md. (T. King, Maryland Acad. of Sciences, Enoch Pratt Free Library Bldg., Baltimore 1.)

17–19. American Inst. of Industrial Engineers, 8th annual, New York, N.Y. (J. L. Southern, AIIE, 145 N. High St., Room 303, Columbus 15, Ohio.)

19–23. American Assoc. of Cereal Chemists, annual, San Francisco, Calif. (C. L. Brooke, Merck & Co., Inc., Rahway, N.J.)

19–24. National Conf. on Social Welfare, annual, Philadelphia, Pa. (F. Schmidt, NCSW, 22 W. Gay St., Columbus 15, Ohio.)

20–21. Society of American Military Engineers, annual, Washington, D.C. (National Headquarters, SAME, 808 Mills Bldg., Washington 6.)

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20–22. International Voice Conf., Chicago, Ill. (H. Von Leden, 30 N. Michigan Ave., Chicago 2.)

20–24. Mass Spectrometry, New York, N.Y. (R. A. Friedel, U.S. Bureau of Mines, 4800 Forbes St., Pittsburgh 13, Pa.)

20–25. International Conf. of Epizootics, annual, Paris, France. (12, rue de Prony, Paris 17e.)

20–31. International Federation of Agricultural Producers, 9th general assembly, Lafayette, Ind. (IFAP, 712 Jackson Pl., NW, Washington, D.C.)

22–24. American Inst. of Chemists, annual, Akron, Ohio. (L. Van Doren, AIC, 60 E. 42 St., New York 17.)

22–24. American Soc. for Quality Control, annual, Detroit, Mich. (L. S. Eichelberger, A. O. Smith Corp., Milwaukee 1, Wisc.)

22–25. International Scientific Radio Union, national spring mtg., Washington, D.C. (J. P. Hagen, U.S.A. National Committee URSI, National Acad. of Sciences, 2101 Constitution Ave., NW, Washington 25.)

23–25. Acoustical Soc. of America, New York, N.Y. (W. Waterfall, ASA, 57 E. 55 St., New York 22.)

25–26. International Cong. for the Study of the Bronchi, Lisbon, Portugal. (F. Lopo de Carvalho, 138 rua de Junqueira, Lisbon.)

25–28. International Cong. of Acupuncture, 9th, Vienna, Austria. (Austrian Assoc. for Acupuncture, 57 Schwenderstrasse, Vienna.)

26–30. Special Libraries Assoc., annual, Boston, Mass. (Miss M. E. Lucius, SLA, 31 E. 10 St., New York 3.)

29–2. American College of Chest Physicians, annual, New York, N.Y. (M. Kornfeld, ACCP, 112 E. Chestnut St., Chicago 11, Ill.)

30–31. Rheology of Elastomers, conf., Welwyn Garden City, Herts., England. (N. Wookey, British Soc. of Rheology, 52, Tavistock Rd., Edgware, Middlesex, England.)

30–1. Endocrine Soc., 39th annual, New York, N.Y. (H. H. Turner, 1200 N. Walker St., Oklahoma City 3, Okla.)

31–2. Society for Applied Anthropology, annual, East Lansing, Mich. (W. F. Whyte, New York State School of Industrial and Labor Relations, Cornell Univ., Ithaca, N.Y.)

June

1–2. American Diabetes Assoc., 17th annual, New York, N.Y. (ADA, 1 E. 45 St., New York 17.)

1–2. Soc. for Investigative Dermatology, annual, New York, N.Y. (H. Beerman, 255 S. 17 St., Philadelphia 3, Pa.)

2–6. Air Pollution Control Assoc., golden anniversary, St. Louis, Mo. Jointly with American Meteorological Soc., American Soc. of Heating and Air Conditioning Engineers, American Inst. of Chemical Engineers, and American Soc. of Mechanical Engineers. (H. C. Ballman, APCA, 4400 Fifth Ave., Pittsburgh 13, Pa.)

2–7. Society of Automotive Engineers, summer, Atlantic City, N.J. (Meetings Div., SAE, 29 W. 39 St., New York 18.)

2–8. International Cong. of Photobiol-

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ogy, 2nd, Turin, Italy. (G. Matli, Istituto di Fisica dell'Universita di Torino, Via Pietro Giuria 1, Corso Massimo d'Azeglio 46, Turin.)

3–5. American Soc. of Refrigerating Engineers, Miami Beach, Fla. (R. C. Cross, ASRE, 234 Fifth Ave., New York 1.)

3–5. Chemical Inst. of Canada, 40th annual, Vancouver, B.C. (CIC, 18 Rideau St., Ottawa 2, Ont.)

3–7. American Medical Assoc., annual, New York, N.Y. (G. F. Lull, AMA, 535 N. Dearborn St., Chicago 10, Ill.)

3–7. American Soc. of Civil Engineers, Buffalo, N.Y. (W. H. Wisely, ASCE, 33 W. 39 St., New York 18.)

3–7. Hospital Cong., 10th international, Lisbon, Portugal. (J. E. Stone, 10 Old Jewry, London, E.C.2, England.)

4–9. Blood Circulation, international symp., London, England. (D. G. James, c/o 11 Chandos St., London, W.1.)

5–7. Therapeutics, 5th international cong., Utrecht, Netherlands. (F. A. Nelemens, Bureau Provisoire, Vondellaan 6, Utrecht.)

6–7. Production Techniques, 1st natl. symp., IRE, Washington, D.C. (A. A. Lawson, Melpar, Inc., 3000 Arlington Blvd., Falls Church, Va.)

6–8. National Soc. of Professional Engineers, Dallas, Tex. (P. H. Robbins, NSPE, 2029 K St., NW, Washington 6.)

8–11. American Planning and Civic Assoc., annual, Little Rock, Ark. (Miss H. James, APCA, 901 Union Trust Bldg., Washington 5.)

9–12. American Inst. of Chemical Engineers, Seattle, Wash. (F. J. Van Antwerpen, AIChE, 25 W. 45 St., New York 36.)

9–13. American Rocket Soc., semiannual, San Francisco, Calif. (J. J. Harford, ARS, 500 Fifth Ave., New York 36.)

9–13. American Soc. of Mechanical Engineers, semiannual, San Francisco, Calif. (C. E. Davies, ASME, 29 W. 39 St., New York 18.)

10–12. American Nuclear Soc., 3rd annual, Pittsburgh, Pa. (W. W. Grigorieff, ANS, P.O. Box 963, Oak Ridge, Tenn.)

10–12. Canadian Soc. of Microbiologists, annual, London, Ont., Canada. (J. A. Carpenter, Dept. of Bacteriology, Ontario Agricultural College, Guelph.)

10–14. Molecular Structure and Spectroscopy Symp., Columbus, Ohio. H. H. Nielsen, Dept. of Physics and Astronomy, Ohio State Univ., Columbus 10.)

10–14. Technical Writers' Institute, 5th annual, Troy, N. Y. (J. R. Gould, TWI, Rensselaer Polytechnic Inst., Troy.)

11–13. American Meteorological Soc., Monterey, Calif. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)

11–15. Ionization Phenomena in Gases, 3rd internatl. conf., Venice, Italy. (U. Facchini, Laboratori CISE, Via Procaccini 1, Milan, Italy.)

12–15. Colloquium of College Physicists, 19th annual, Iowa City, Iowa. (J. A. Van Allen, Dept. of Physics, State Univ. of Iowa, Iowa City.)

16–20. American Soc. of Mammalogists, annual, Lawrence, Kansas. (B. P. Glass, Dept. of Zoology, Oklahoma A.&M. College, Stillwater.)

16–21. American Soc. for Testing Materials, Atlantic City, N.J. (R. J. Painter, ASTM, 1916 Race St., Philadelphia 3, Pa.)

17–19. Astronomical Soc. of the Pacific, annual, Flagstaff, Ariz. (S. Einarsson, Univ. of California, Berkeley 4.)

17–19. Health Physics Soc., 3rd annual, Pittsburgh, Pa. (H. W. Patterson, Radiation Lab., Univ. of California, Berkeley 4.)

17–20. Carbon Conf., 3rd, Buffalo, N.Y. (Carbon Conf., Univ. of Buffalo, Buffalo 14.)

17–20. Institute of Aeronautical Sciences, natl. summer, Los Angeles, Calif. (S. P. Johnston, IAS, 2 E. 64 St., New York 21.)

17–21. American Soc. for Engineering Education, annual, Ithaca, N.Y. (W. L. Collins, Univ. of Illinois, Urbana.)

17–21. Canadian Medical Assoc., 90th annual, Edmonton, Alberta, Canada. (CMA, 244 George St., Toronto, Ont., Canada.)

17–22. Coordination of Galactic Research, internatl. symp., Stockholm, Sweden. (P. T. Oosterhoff, University Observatory, Leiden, Netherlands.)

17–22. Internal Combustion Engine Cong., 4th internatl., Zurich, Switzerland. (C. C. M. Logan, British National Committee, 6 Grafton St., London, W.1.)

19–21. Association for Computing Machinery, annual, Houston, Tex. (J. Moshman, ACM, 2 E. 63 St., New York 21.)

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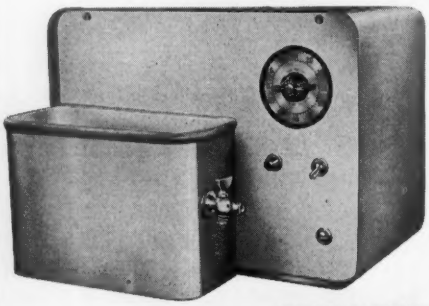

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■ SERIAL MARKER photographically assigns a 4- or 5-digit number to a light-sensitive emulsion. In the darkroom, before development, the film or plate is held against a Lucite window through which a number is projected by pressing a switch. The number is advanced by pressing a second button. Resetting may be accomplished by rotating a knob. (Spex Industries, Inc., Dept. S189)

■ RADIOACTIVE MESCALINE [2-(3,4,5 trimethoxyphenyl) ethylamine-1-C^{14} sulfate] is available in research quantities with a specific activity of about 4 μc/mg for research concerning mental illness and nervous disorders. (Beta Laboratories Inc., Dept. S192)

■ GLASS—its manufacture, applications, and history—is the subject of a 64-page booklet entitled *This Is Glass.* (Corning Glass Works, Dept. S198)

■ PIPETTE DRYER handles pipettes up to 375 mm in length and accommodates standard pipette washer racks up to 6 in. in diameter. The dryer is made of an anodized aluminum cylinder; it has a 300-watt heater and is suitable for operation on a-c or d-c power. (Chicago Surgical and Electrical Co., Dept. S197)

■ CHILLING MACHINE permits control of temperatures from 25°F to – 135°F. The chamber has a capacity of 2 ft^3. Thermal capacity is approximately 400 Btu/hr at – 120°F. (Cincinnati Sub-Zero Products, Dept. S199)

■ MICROWAVE GENERATORS and sources cover frequencies from 18,000 to 50,000 Mcy/sec. The interchangeable tuning units require no further adjustment after plug-in to the basic unit. Self-contained instruments provide continuous-wave or modulated signals of known frequency. (Polarad Electronics Corp., Dept. S200)

■ TIME-SIGNAL RECEIVER is specifically designed to receive radio transmissions from National Bureau of Standards stations WWV or WWVH. It uses crystal control for fixed frequency selection. Less than 2 μv of signal is required to produce a signal-to-noise ratio of 10 db on all operating frequencies. (Specific Products, Dept. S209)

■ VACUUM GLAND for laboratory apparatus is available in four standard tapers, 24/40, 29/42, 34/45 and 45/50, for either 6 or 10-mm shafts or tubing. Said to be vacuum-tight to 5×10^{-6} mm-Hg and usable at temperatures up to 200°C, the gland features O-ring seals and a Teflon body. (Arthur F. Smith Co., Dept. S205)

■ DIAPHRAGM FEEDER for removing concentrated chemicals directly from shipping containers permits handling minute amounts of most corrosive chemicals. Pumping rates, from 0.8 to 8.0 gal/24-hr period, can be adjusted by varying the stroke length and the stroking frequencies. (Proportioneers, Inc., Dept. S213)

■ ELECTRON PARAMAGNETIC RESONANCE SPECTROMETER is capable of inducing and observing electron paramagnetic resonance in substances possessing a resultant electronic magnetic moment. In the case of an unpaired electron, a strong magnetic field applies a torque to the axis of the resultant magnetic moment. The resulting rate of gyroscopic precession is characteristic of the particular atom and its environment. A variety of conditions influencing the resultant electron magnetic moment can be studied in this way—for example, free radicals, sites of radiation-damage, and impurities in semiconductors. The laboratory spectrometer operates at X-band frequency (nominally 9.5 kMcy/sec). The sample requirement can be defined in moles of electron spins and is usually a small fraction of 1 cm^3. (Varian Associates, Dept. S206)

■ DIRECT-WRITING OSCILLOGRAPH uses a jet of ink directed at the moving chart paper as the writing mechanism. A nozzle attached to a galvanometer movement, fed by a high-pressure membrane pump, produces the jet. Since the jet does not contribute to the moment of inertia of the system, a high resonant frequency of about 650 cy/sec is possible. Compensation circuits in a preamplifier permit recording to 1000 cy/sec. (Elema Aktiebologet, Dept. S202)

■ TELEVISION CAMERA for closed-circuit use measures 1⅞ by 2⅜ by 4½ in. Used with an *F*1.9 lens, the camera requires 10 ft-ca of scene illumination for clear-contrast pictures. Photoelectric iris control provides accommodation to variation of lighting of 100 to 1. The camera requires 350 w of 115-v, 60-cy/sec power (Radio Corporation of America, Dept. S212)

■ TORQUE TRANSDUCERS for the ranges 0.05 and 0.5 in. lb operate without brushes and slip rings and without contact between the torque shaft and pickup

housing. They operate on the variable permeance principle. Sensitivity and linearity are not affected by shaft speed. (Crescent Engineering and Research Co., Dept. S214)

■ EVENT RECORDER uses electric writing to record 78 channels of on-off information. Chart speeds of 2 and 10 in./min provide continuous recording for 50 hr and 10 hr, respectively. An internal power supply furnishes writing voltage for the styli. (Brush Electronics Co., Dept. S215)

■ DIGITAL COMPARATOR accepts a parallel binary signal, compares it with another similarly presented signal, and provides as output a difference-modulated alternating signal. If the second signal represents feedback, the output may be used to initiate control operations. The device is transistorized throughout and will operate through a range of temperatures from −55° to +55°C. Band width is limited by carrier frequency. (Norden-Ketay Corporation, Dept. S204)

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■ VACUUM-TUBE VOLTMETER measures d-c voltages from 2 mv to 1000 v with 121 Mohm input resistance. Alternating voltages can be measured from 50 cy/sec to ultrahigh frequencies. Three probes cover the frequency range. As an ohmmeter, the instrument is calibrated from 0 to 500 with eight multiplier ranges from ×1 to ×10 Mohm. (Allen B. DuMont Laboratories, Inc., Dept. S226)

■ TIME-GATE COUNTER uses time sampling to accomplish conversion of units of measurands that are presented to the counter as frequency analogs. The sampling interval is adjustable from 0.1 msec to 0.9999 sec in steps of 0.1 msec. The counter thus introduces a calibration constant so that the measured quantity is displayed directly in desired units. A counter with gate times up to 9.9999 sec is also available. (Dynac Inc., Dept. S211)

■ ULTRASONIC GENERATORS provide 500-w output at a varied range of frequencies. Depending on the model, the generators operate at a nominal fixed frequency of 40 kcy/sec or at any frequency between 20 kcy and 2Mcy/sec. (Gulton Industries, Inc., Dept. S229)

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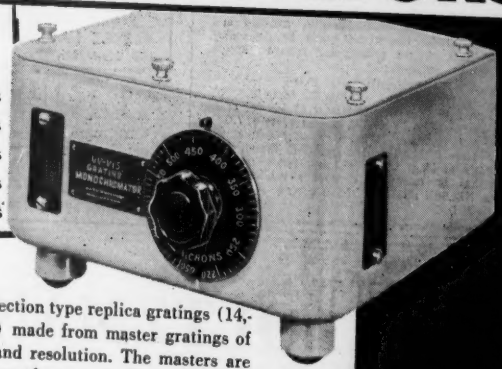

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THE PLENTIFUL RARE EARTHS

some facts about a clubby clan of elements that are rare in name only

a report by LINDSAY

We got to thinking the other day that perhaps a lot of industry folks are passing up a diamond-studded opportunity because they believe the rare earths are unavailable in commercial tonnages. Nothing could be farther from the truth. Rare earths are *not* rare! Commercial salts of the rare earths are available, right now, for prompt shipment in quantities from a gram to a carload.

That the rare earths are so plentiful is due, in large part, to Lindsay. During the last 50 years, Lindsay has developed the extraction and separation of rare earths to a high degree.

New equipment and processes are now in operation at Lindsay's West Chicago plant and are producing greater quantities of these versatile materials in higher purities than before.

FROM 57 THROUGH 71—Some chemists call rare earths Lanthanides, Lanthanons or the Lanthanum Series. Actually they are not earths, but trivalent metals, a rather amazing family of elements . . . atomic numbers 57 through 71. They are grouped together because they are always found together, with thorium and yttrium, in ores such as monazite, and all have closely related properties. While rare earths are technically metals, Lindsay produces them in chemical salt forms—individually or in combinations.

ATOMIC NUMBER	ELEMENT
39	Yttrium
57	Lanthanum
58	Cerium
59	Praseodymium
60	Neodymium
62	Samarium
63	Europium
64	Gadolinium
65	Terbium
66	Dysprosium
67	Holmium
68	Erbium
69	Thulium
70	Ytterbium
71	Lutetium
90	Thorium

SOME USES FOR RARE EARTHS

LANTHANUM—As lanthanum oxide in a high refractive optical glass, particularly for aerial cameras and other instruments.

CERIUM—Glass polishing. Scavenger in explosives production. Radiation protection glass for atomic reactors. Opacifier for porcelain. Oxidizing catalysts in organic preparations. Ultraviolet light absorber.

MIXED RARE EARTHS—Misch metal for lighter flints and alloy uses. Motion sickness medication. Cores of arc carbon electrodes. Aluminum and magnesium alloys.

PRASEODYMIUM & NEODYMIUM—Dichroic colorants for ceramic glazes and glass. Used in better grade sun glasses. They do not lower light permeability and index of refraction when used as colorant or decolorizer. Ceramic capacitors.

The rare earths are becoming increasingly important in the production of steel and steel alloys. Small quantities added to the metal in the ladle result in a strong, fine-grained steel. Steel thus treated has great resistance to low temperature oxidation and corrosion. Stainless varieties have better hot and cold workability. Silicon and electrical grade steels have better electrical qualities.

Rare earths added to cast iron act as powerful deoxidizers and help remove sulfur from the molten metal. They are responsible for cast iron that is resistant to scaling at higher temperatures and to certain corrosive atmospheres. In malleable metals, they act as a carbide stabilizer.

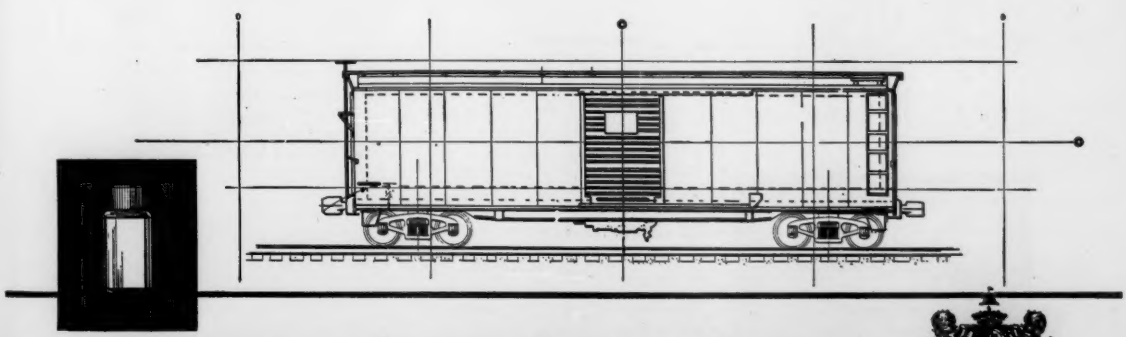
Magnesium-rare earth-zirconium alloys have excellent casting qualities and mechanical properties that make them ideal for important light-weight stressed components of aircraft engines.

Other rare earth compounds are used extensively for waterproofing, mildewproofing, weighting and dyeing of fabrics and compounding printing inks and phosphors.

LIKE AN ICEBERG—You might compare uses for the rare earths to an iceberg. What you see is only a small part of what lies undiscovered under the surface. In all probability, there is a real place for one or more of the rare earths in your operations. New uses—and profitable ones, too—are being discovered constantly. These versatile elements offer so much promise in so many different ways they merit your investigation.

To industries interested in the rare earths, we offer detailed technological data compiled over the years by our research staff. We will also furnish samples for experimentation.

And please remember . . . the rare earths are *plentiful*. Lindsay can supply you with quantities from a gram to a carload.



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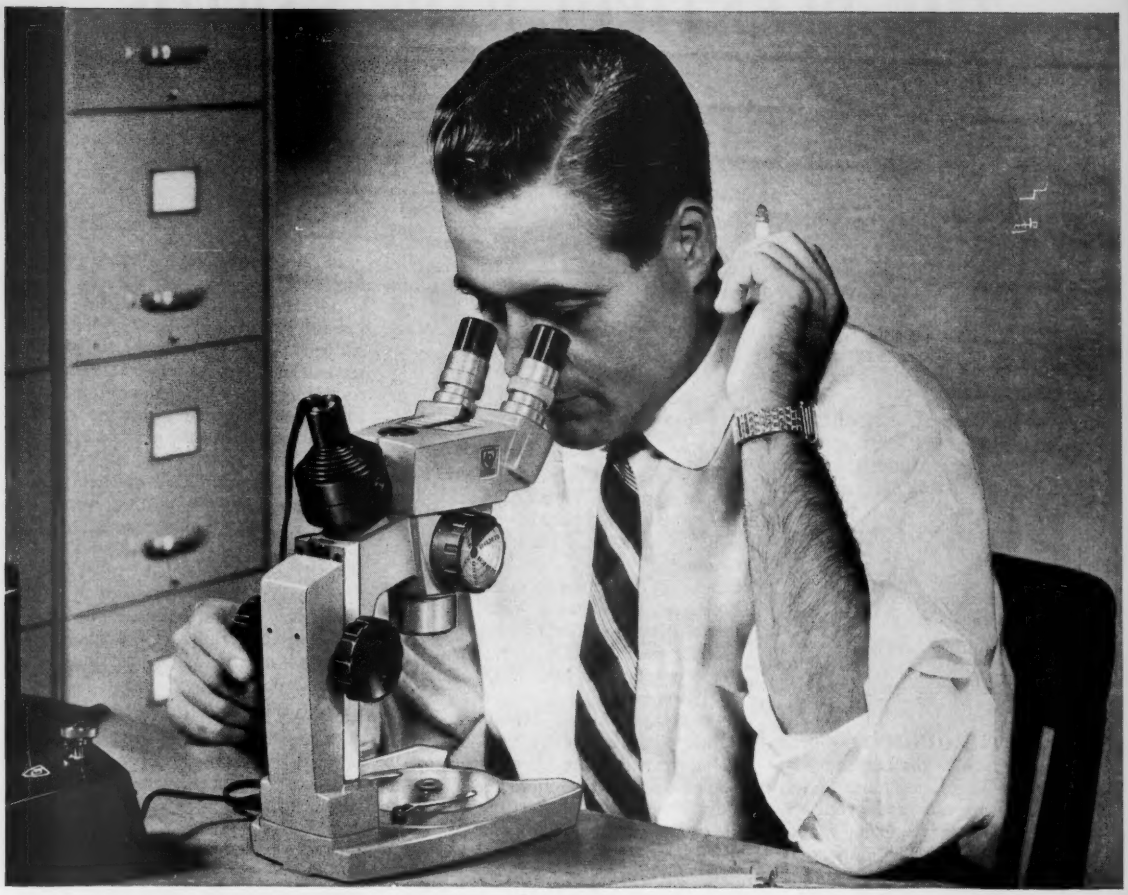

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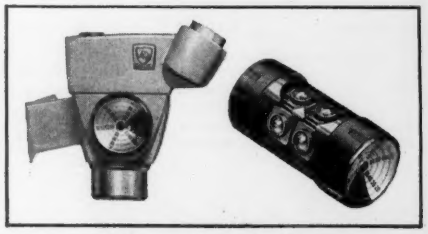

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